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The eye and its diseases x

THE EYE AND ITS DISEASES.

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THE EYE AND ITS DISEASES.

THE ANATOMY AND PHYSIOLOGY OF THE EYE.

THAT which we are accustomed to call THE EYE is a complicated structure of many different parts, not all of which are directly concerned in the act of vision. The whole may be properly termed *the visual apparatus*, and it may be conveniently described under four heads : (1) The Orbits ; (2) The Eyeball, or Globe of the eye, —the eye proper ; (3) The Optic Nerves ; (4) The Appendages of the Eye.

The Orbits.

The Orbits are the bony cavities in the front of the skull, in which the eyeballs are contained. (See Fig. 43.) They are shaped like four-sided pyramids. The small ends of these pyramidal cavities are directed backward and are each pierced by an opening called the *optic foramen* (Latin, *foramen*, an opening), through which run nerves and blood-vessels. The large ends of the orbits open upon the face, and these facial openings have a strong, bony edge which protects the eyeball from blows, etc. The orbits are lined by a layer of fatty material, which forms elastic cushions for the eyeballs to rest upon, and thus gives them still further protection against injury.

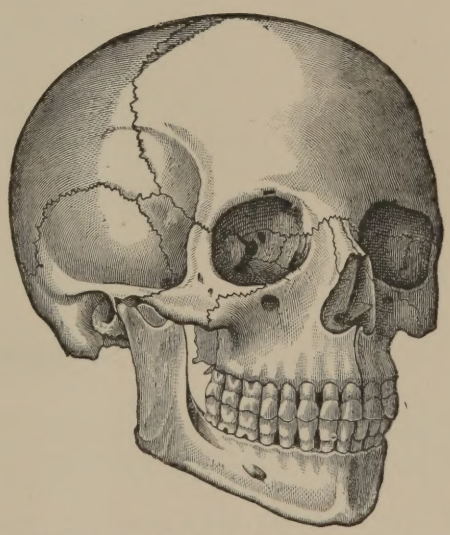

FIGURE 43.—Skull, showing the orbits or bony cavities which contain the eyes. At the bottom of the right orbit is seen the optic foramen.

The Eyeball.

The *Eyeball,* or *Globe* of the eye, lies in the front of the orbit and projects a little beyond the lower edge of that cavity. Its shape is best described as that of a spheroid, with a part of a smaller sphere projecting from the front of it, as is shown in Fig. 44. Its average diameters are: antero-posterior, about $\frac{95}{100}$ inch; vertical, about $\frac{90}{100}$ inch; transverse, about $\frac{92}{100}$ inch. Its weight is $1\frac{1}{2}$ to 2 drachms, and its volume is about $\frac{1}{3}$ cubic inch. The centre of the anterior part (the *cornea*) of the eyeball is called *the anterior pole* of the eye. The centre of the posterior part is *the posterior pole.* A line running through the eyeball from pole to pole is called *the optic axis.*

Externally, is the wall or capsule of the globe, which is usually described as made up of three different layers, the whole being about one-sixteenth of an inch thick at the thickest part, which lies posteriorly. These layers are called the *investing membranes,* or *tunics,* or *coats* of the eyeball. The hollow globe thus formed is filled by materials of a fluid and gelatinous consistency which are known as *the humors of the eye.* The following are the names of the investing membranes, passing from without inward:

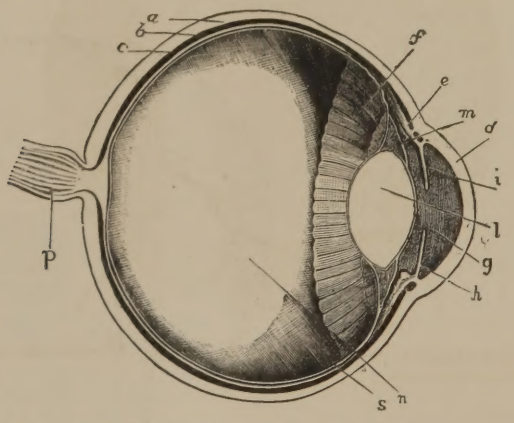

FIGURE 44.—Diagram of a vertical section of the eyeball: *a*, sclerotic; *b*, choroid; *c*, retina; *d*, cornea; *e*, ciliary muscle; *f*, ciliary processes; *g*, anterior chamber; *h*, posterior chamber; *i*, iris; *l*, lens, in its capsule; *m*, suspensory ligament of lens, or zonula of Zinn; *n*, space occupied by vitreous humor; *p*, optic nerve; *s*, location of ora serrata.

(1) *The Sclerotic and Cornea;* (2) *The Uveal Tract,* which comprises the *choroid membrane, the ciliary body,* and *the iris;* (3) *The Retina.* The first is called the *fibrous* layer, the second the *vascular* layer, and the third the *nervous* or *perceptive* layer.

The humors are called: (1) *The Aqueous;* (2) *The Crystalline,* also called *the lens,* and (3) *The Vitreous.* (See Fig. 44.)

The outermost tunic of the eyeball, called the *Sclerotic* (from the Greek σκληρα, *hard*), is really composed of *two* different membranes, as may be seen by Fig. 44. One of the membranes, constituting the posterior five-sixths of the tunic, is called *the sclerotic.* The other, forming the anterior one-sixth, is called *the cornea.* This tunic is the toughest of all, and serves to maintain the shape of the globe and to protect the parts within. It is the true *capsule* of the globe, as the other so-called tunics are very delicate and are rather designed for the purposes of sight. The sclerotic is pierced behind by a roundish opening, about one-twelfth of an inch in diameter, for the entrance of the optic nerve. (See Fig. 44.) Its anterior portion can be plainly seen, and is known as "the white of the eye." This part is covered by a glossy membrane called *the conjunctiva.* (See p. 231.)

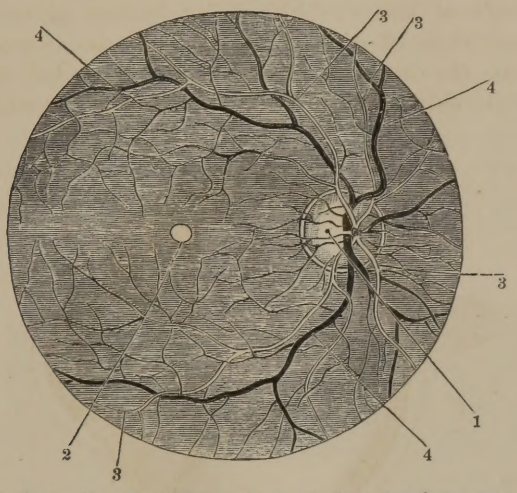

FIGURE 45.—1, Optic papilla; 2, yellow spot; 3, arteries; 4, veins—as seen on looking into the eye with an ophthalmoscope.

The remainder (the anterior one-sixth) of the outer tunic is called *the cornea* (from the Latin, *cornu,* a horn). It is also a firm, tough membrane, but, unlike the sclerotic, it is transparent, so as to permit light to enter the eye. It has a beautiful, clear, glistening appearance, and is aptly termed "the window of the eye." It is more prominent than the surrounding sclerotic. If an eyeball is cut across, as in Fig. 44, the cornea is seen projecting

from the sclerotic in front, like a part of a smaller sphere engrafted upon a larger one. This prominence of the cornea can also be seen by looking at another's eye in profile. The edges of the sclerotic overlap the cornea a little, in front and behind, so that the latter is usually described as fitting into the sclerotic like a watch-crystal into its case. It must be remembered, however, that the two membranes, although so different in aspect, really form one continuous tissue, and cannot be separated, as the above comparison with the watch-crystal would seem to imply. The cornea contains nerves, but no blood-vessels, its nourishment being derived from the vessels of neighboring parts.

The next layer of the wall of the globe is called *the uveal tract* (from the Latin *uva*, a bunch of grapes). This name was probably given to it on account of the peculiar purplish color seen when the eye is cut open. The uveal tract is divided by anatomists into three parts, which, although continuous with one another, are quite different. These three parts are called respectively, *the choroid*, *the ciliary body*, and *the iris*.

The choroid membrane is the part of the uveal tract which lies furthest back. It covers the internal surface of the sclerotic as far forward as a line a little in front of the centre, or equator, of the globe. This imaginary boundary-line is called the *ora serrata*, or *serrated boundary*. (See Fig. 44.) The choroid is composed chiefly of a network of small blood-vessels. Mingled with these are pigmented cells (little cells containing a dark coloring-matter), and a few muscular fibres.

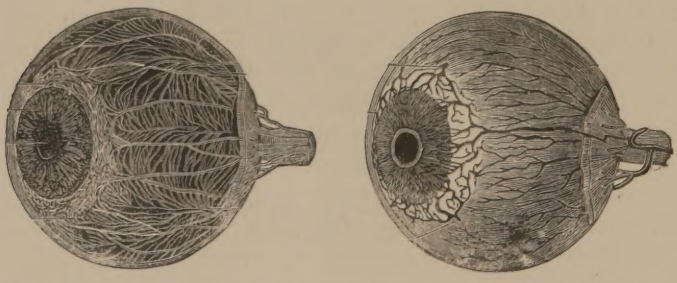

FIGURE 46.—The choroid coat as it appears after the sclerotic coat has been removed. Showing the arrangement of the blood-vessels, etc.

The ciliary body is the part of the uveal tract beginning at the ora serrata and extending forward to the iris. (See Fig. 44.) It is composed chiefly of the ciliary muscle, this being covered on its internal surface by a thin continuation of the choroid. The ciliary

muscle is a layer of muscular fibres, and has the form and position shown in Fig. 44. It is the muscle of *accommodation*, which will be found fully described on page 23. The choroid membrane which covers the internal surface of the ciliary muscle is thrown into seventy or eighty parallel folds, running from before backward, and forming a plaited zone like a lady's ruffle. These folds are called *the ciliary processes*. It may be seen from Fig. 44, that the ciliary muscle and processes form a complete circle or collar about one-eighth of an inch wide, which runs around the interior of the eyeball just behind the edge of the cornea. The region corresponding to this circlet is called *the ciliary region* of the eyeball, and is of very great importance in diseases and injuries of the eye, as they are specially dangerous in this locality.

The iris (Latin, *iris*, rainbow) is the part of the uveal tract lying in front of the ciliary body. By referring to Fig. 44 it will be seen that the membrane is now no longer in contact with the outer tunic, but is bent inward away from it, and hangs free in the interior of the globe. By looking into another's eye the iris is plainly seen hanging vertically, like a circular curtain, a short distance behind the cornea. It is, in fact, what is called "the colored part of the eye." A circular hole is left in the centre of the iris, which is called "the pupil of the eye," and it usually appears jet-black.* The posterior surface of the iris is covered by a layer of pigmented cells. The iris contains muscular fibres whose office is to alter the size of the pupil. The movements of the pupil are largely reflex—that is, occurring without our knowledge or will, but simply from the effect of the light which enters the eye. If the eye is exposed to a bright light, the pupil contracts so as to lessen the amount admitted within the eye; if exposed to a dim light, the pupil dilates so as to admit more. The pupil likewise varies in size in the accommodation and convergence of the eye, independently of the amount of light (p. 237). The iris also contains blood-vessels and nerves. Besides the layer of pigment on the posterior surface of the iris, which is designed to prevent the light from shining through it into the eye, there are other pigmented cells in the superficial parts of the membrane. It is

* The reason why the pupil of another's eye looks black to us is this: The interior of the eye would appear illuminated, if at all, by reason of the light which had entered the eye being reflected back again to us. Some of the light is so reflected, but these reflected rays, in coming out from the eye through the pupil, retrace precisely the same path by which they entered. Hence, we cannot place our eye in their path without putting our head between the observed eye and the source of light, and so cutting off the illumination. This difficulty is overcome by an instrument called the ophthalmoscope, by means of which the interior of the eye can be seen through the pupil.

chiefly these latter which cause the beautiful colors seen in the iris. The different colors of eyes, however, are not so much due to differently-colored pigment in the iris as to different quantities of the same pigment. Thus in light eyes there is very little; in dark eyes there is more, according to the shade of color. The same conditions prevail to a less extent throughout the rest of the uveal tract. As a rule, the eyes of children at birth are light, and, if they are to be dark, they become so gradually, by the deposit of pigment in the iris as the child grows older. In the albino, pigment is almost entirely absent from all parts of the eye, as well as from the hair, skin, etc.

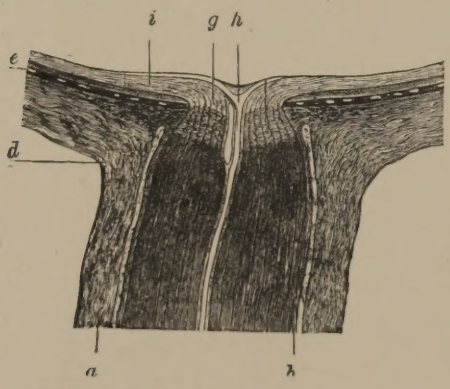

FIGURE 47.—Showing the entrance of the optic nerve into the eye and the spreading of its fibres into the retina: *a*, sheath of optic nerve; *b*, optic nerve; *d*, sclerotic; *g*, optic nerve filaments spreading into retina; *i*, the retina; *h*, location of the central artery.

Internal to the choroid, and attached to it, is the *retina*, which is the innermost layer of the wall of the globe. It extends forward only to the *ora serrata*, which was described on page 224. (See Fig. 44.) It is very delicate and quite translucent, and is composed chiefly of nerve-tissue designed to receive the images of external objects which are formed within the eye. (See page 236.) When viewed under a microscope it is seen to be composed of several

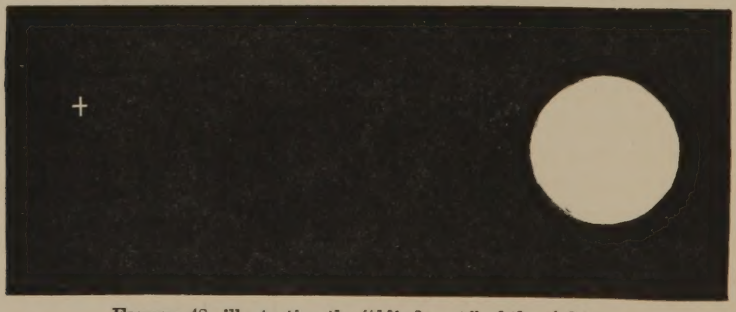

FIGURE 48, illustrating the "blind spot" of the right eye.

different layers. One of these layers of the retina is formed by an expansion of the optic nerve after it has pierced through the capsule of the globe. The nerve-fibres bend over the edges of the opening in the capsule, and radiate into the retina in all directions. Strangely enough, these fibres are not sensitive to light—that is,

when light enters the eye they do not perceive it at all. The point of entrance of the optic nerve itself, *the optic papilla,* forms a blind spot of corresponding size in our field of view. This is called *the blind spot of Mariotte,* after the man who first described it. Its existence can be proved by the following simple experiment: On a sheet of paper draw a small cross, and, three or four inches to the right of this, make a dot about half an inch in diameter. Hold this paper in front of the right eye, and, with the other eye covered, look *steadfastly* at the cross. By moving the paper backward and forward a point will be found where the dot will disappear from view entirely. The reason of this is, that under the above conditions the image of the dot falls exactly upon the optic papilla; and, as it is not perceived, the experiment shows that the papilla is really a blind spot. Because the optic nerve-entrance is not at the centre of the eyeball, the blind spot does not fall directly in our line of vision—that is, in the centre of our field of view. Hence it occasions no inconvenience, and centuries elapsed before it was even discovered.

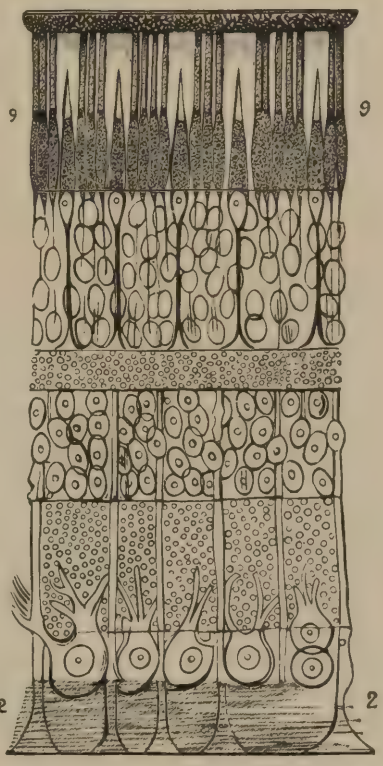

FIGURE 49.—Showing the layers of the retina, largely magnified; No. 2 shows the layer of optic nerve fibres; No. 9, the layer of rods and cones.

One portion of the retina is known as the layer of "rods and cones," from the peculiar shape of the elements composing it. This layer is almost universally considered as the true *perceptive* layer of the retina. This view is thought to agree best with anatomical facts and with the results of experiments. It is assumed that, in accurate vision, the image of the object is formed exactly in this layer of the retina (page 236).

There is one point of the retina which is of great importance, and that is the *macula lutea,* or *yellow spot.* This is a region about $\frac{1}{25}$ to $\frac{1}{17}$ inch in diameter, and situated about $\frac{1}{12}$ to $\frac{1}{10}$ inch to the outer side of the optic papilla. (See Fig. 45.) In its centre is a little

pit or excavation called the *fovea centralis.* This spot is the centre of direct vision ; that is, it is the part of the retina most sensitive to light and color, and the part which is always turned toward the object looked at. From this point the sensitiveness of the retina grows less and less in all directions. The blood-vessels which enter the eyeball through the centre of the optic nerve (see p. 229) branch into the retina in all directions. There are no vessels whatever in the *fovea centralis.* There is a layer of beautiful hexagonal, pigmented cells on the side of the retina next to the choroid. (See Fig. 50.) This pigmented layer of the retina is continued forward over the internal surface of the ciliary body and of the iris. It is of great importance for vision to have the interior of the chamber of the eyeball thus darkened (p. 234).

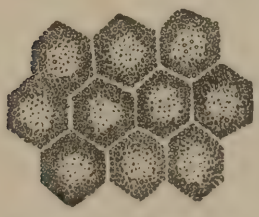

FIGURE 50.—Pigmented cells from the human retina, surface view, largely magnified.

The *aqueous humor* is a transparent, watery fluid, filling the spaces indicated in Fig. 44 by *g* and *h.* The space marked *g* is called the *anterior chamber* of the eye. The space marked *h* is called the *posterior chamber.* If the eye is looked at from one side, the anterior chamber (see Fig. 44) can be seen as the space between the cornea and the iris.

The *Crystalline humor* or *Lens* is a transparent, elastic, biconvex body looking like an ordinary glass magnifying-lens. It is of circular outline, about $\frac{9}{25}$ inch in diameter. It is of quite firm consistence. It is enclosed in a transparent, elastic capsule (about $\frac{1}{2000}$ inch thick), and is suspended by a ligament just behind the iris, so that it lies about one-seventh of an inch back from the cornea. (See Fig. 44.) It contains no vessels or nerves, and absorbs its nourishment from surrounding parts. The suspensory ligament of the lens is called the *zonula of Zinn* (Latin, *zonula*, a little girdle).

The *vitreous humor*, or *hyaloid body* (Latin, *vitreum*, glass; Greek, ὑαλος, glass), fills the interior of the eyeball behind the lens. (Fig. 44.) It is a transparent, colorless, gelatinous substance, looking like liquid glass. It contains no blood-vessels, and absorbs its nourishment from the walls of the globe. A good idea of the vitreous humor and crystalline lens can be very easily obtained by cutting open the eye of a pig or a sheep. Much can be learned about other parts of the human eye in the same way. Eyes of animals can be obtained from any butcher.

The Optic Nerves.

The *Optic Nerves* are the nerves of the special sense of sight, and connect the eyeballs with the brain. (See Fig. 51.) They have their origin in the base of the brain. These nerves enter the orbits through the optic foramina, and, running forward, each nerve passes into its corresponding eye a little to the inner side and a little below the posterior pole of the globe. After penetrating the wall of the globe the nerve-fibres spread out into the retina in all directions, forming one layer of that membrane. (See p. 227.) At its point of entrance the nerve projects into the eye a little beyond the level of the internal surface of the wall of the globe, forming a round or oval prominence called the *optic papilla* or *optic disc.* (See Fig. 45.) As soon as the nerve-fibres leave the disc to branch into the retina they become transparent. Hence, in looking into an eye with the ophthalmoscope, the nerve-fibres cannot be seen bending over from the disc into the retina. The disc alone is visible, looking like a round, whitish spot, and the appearance is as if the nerve had been cut off short at that point. (See Fig. 45.) A main artery, called *the central artery of the retina*, enters the nerve about four-fifths of an inch behind the eyeball and runs forward in the centre of it. At the optic disc it divides into several branches, which bend over the edges of the disc and radiate into the retina. The *central vein* accompanies the artery in its course and conveys part of the blood out from the eye.

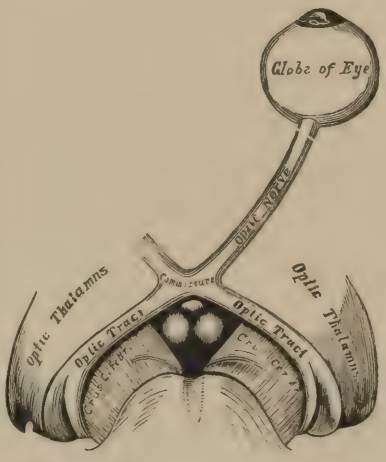

FIGURE 51.—Base of brain and course of the optic nerves.

The Appendages of the Eye.

The eyeball is moved by six muscles. These start from the walls of the orbit, and are attached to the outer or sclerotic coat of the eyeball. Four of the muscles are called the *recti* muscles, from their straight course. The other two are called the oblique muscles. (See Fig. 52.) The names of the muscles are the *superior rectus*, the *inferior rectus*, the *external rectus*, the *internal rectus*, the *superior oblique*, and the *inferior oblique.*

The eyeball, excepting its most anterior portion, is surrounded by a membranous capsule (called Bonnet's and Tenon's capsule), through which the muscles penetrate just before becoming at-

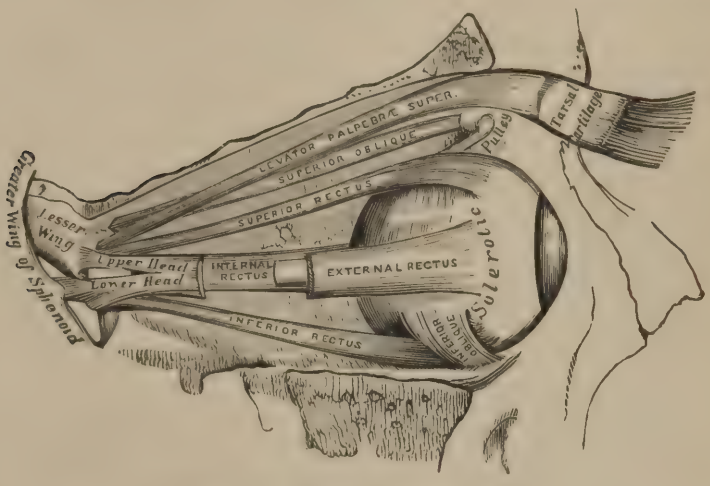

FIGURE 52.—Muscles of the right eyeball.

tached to the sclerotic. The eyeball rotates freely in this socket, and its movements are facilitated by this arrangement.

The *eyelids* (or, in Latin the *palpebræ*) are the two protecting curtains placed in front of the eyeball. They are movable, and can be opened and closed at will, as in the so-called *opening* and *shutting* of the eyes. They also move independently of the will, as when a particle of dust strikes the eye, or, upon sudden exposure to a bright light, etc. This involuntary action of the lids protects the eyes from many unexpected dangers. The slit between the edges of the lids is called by anatomists the *palpebral fissure.* It is chiefly the size of this fissure which causes the appearance of large and small eyes, as the size of the globe itself varies but little. The outer corner of this fissure (the corner towards the temple) is called the *external canthus.* The inner corner is the *internal canthus.* (See Fig. 53.)

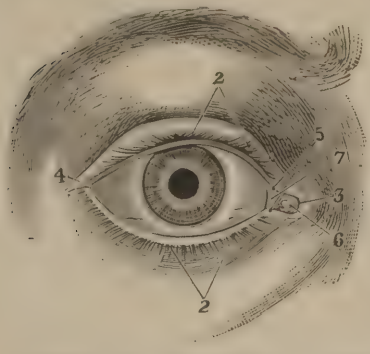

FIGURE 53.—The eyelids: 2, 2, cilia or eyelashes; 3, inner canthus; 4, outer canthus; 5, puncta lachrymalia; 6, caruncular lachrymalis; 7, semilunar fold.

The lids are composed of several different substances. (See

Figs. 13 and 14.) Outside is the skin, which is a continuation of the skin of the rest of the body. At the edge of the lid the skin grows thinner and passes into a mucous membrane, just as the skin about the mouth passes into the mucous membrane of the lips. This mucous membrane is called the *conjunctiva* (Latin, *conjungere*, to join together), and it lines the inner surfaces of the lids, and passes thence over upon the front of the eyeball, covering the sclerotic as far as the edge of the cornea, where it ends.* (See Fig. 54.) This folding over of the conjunctiva from the upper and lower lids upon the eyeball constitutes what are called the *superior* and *inferior conjunctival folds;* also called the *retrotarsal* or *palpebral folds.* The little pouches thus formed above and below are called respectively the *superior* and *inferior conjunctival culs-de-sac.* (See Fig. 54.) A crescentic fold of conjunctiva can

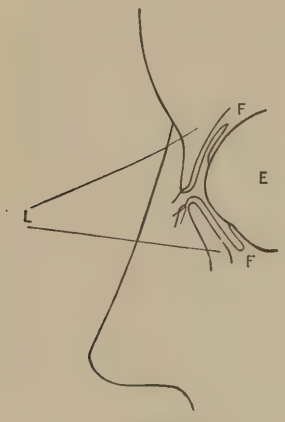

Fig. 54.

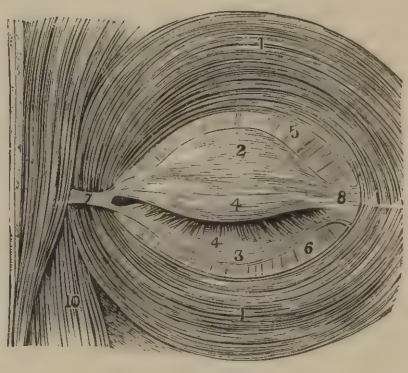

Fig. 55.

Figure 54.—Vertical section of the upper and lower conjunctival folds: *e*, eyeball; *l*, eyelids; the fine lines within the lids represent the conjunctiva covering the inner surfaces of the lids and reflected upon anterior surface of globe, forming *palpebral folds*, and conjunctival *culs-de-sac* at *f f*. Lids drawn away from eyeball to show conjunctiva.

Figure 55.—1, 1, the orbicularis muscle which closes the eyelids; 2, the cartilage of the upper lid; 3, cartilage of the lower lid; 4, 4, edges of the lids.

also be seen on the front of the eyeball at the inner corner of the lids. This is called the *semilunar fold*, or *plica semilunaris.* The conjunctiva covering the front of the eyeball (*the ocular conjunctiva*) is thin, and is very loosely attached. The conjunctiva also dips down into the little glands of the lids, forming a lining for them, and also lines the lachrymal passages, becoming thus con-

* A very delicate prolongation of the conjunctiva, consisting of minute cells, passes over the front of the cornea.

tinuous with the mucous membrane of the nose and mouth (p. 233).

Between the skin on the outside and the conjunctiva on the inside are enclosed the other structures of the lids. Just beneath the skin is a layer of muscular fibres, a part of the *orbicularis** muscle. (See Fig. 55.) It is what is called a *sphincter* muscle (*Greek*, σφιγγω, *to constrict*), and its action is to close the lids. There is another muscle, whose office it is to lift the upper lid, called the *levator palpebræ superioris muscle*. (Fig. 52.)

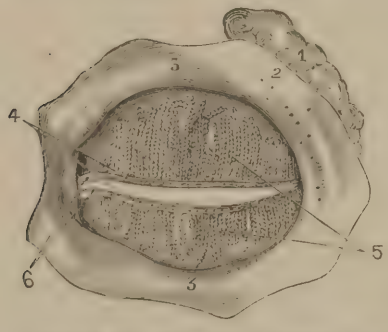

FIGURE 56.—Showing a portion of the eyelids as seen from within: 1, Lachrymal gland; 2, openings of the lachrymal ducts; 3, 3, conjunctiva lining the eyelids; 4, openings of the Meibomian glands; 5, Meibomian glands; 6, puncta lachrymalia.

Beneath the orbicularis muscle is the piece of cartilage which forms the framework, as it were, of the lid. In the cartilages lie the *Meibomian glands*, so called after the anatomist Meibomius. (See Fig. 56 adjoining.) They furnish an oily secretion, which lubricates the edges of the lids and prevents their sticking together. This greasing of the edges of the lids also tends to prevent the tears from running over upon the cheek. Beneath the cartilage lies the conjunctiva, which has already been described.

The eyelashes or *cilia* (Latin, *cilium*, an eyelash) are the rows of short, thick hairs on the edges of the lids. Those of the upper lid curve upward, and those of the lower lid downward—an arrangement which keeps them from interfering with vision, and from interlocking when the lids are closed. They serve both for protection and ornament.

The small red body seen lying upon the semilunar fold at the inner corner of the palpebral fissure is called the *lachrymal caruncle*.

The Lachrymal Apparatus.

The *lachrymal* (Latin, *lacryma*, a tear), or *tear-apparatus* of the eye, consists of the *lachrymal glands*, in which the tears are formed, and of the *lachrymal passages*, which are designed to conduct the tears away from the eye after they have served their purpose. The largest lachrymal gland is situated just above the eye-

* Latin, for circular.

ball, in the outer corner of the orbit, as shown in Fig. 56. Below this there are a number of small glands lying in the upper fold of the conjunctiva, and called *accessory lachrymal glands.* The openings of the ducts, by which the tears escape from the glands, also lie in this same fold.

The lachrymal passages are shown in Fig. 57. If the lids are looked at closely, a slight prominence can be seen on the edge of each, about one-fifth of an inch from the inner corner. On still closer examination, each of these prominences can be seen to contain in its centre a minute hole, about the size of a pin-hole. This hole can be most easily seen in the lower lid by pulling the lid down a little with the finger, so as to roll its edge outward. Each of the prominences is called a *lachrymal papilla.* Each of the holes is called a *lachrymal punctum* (Latin, *punctum,* a small hole), and is the entrance to a little canal, called a *lachrymal canaliculus* (Latin, *canaliculus,* a little channel). These canals are about one-quarter to one-third of an inch long, and about one twenty-fifth of an inch in diameter, and run horizontally along the edge of the lid toward the nose to empty into the lachrymal sac. The *lachrymal sac* lies in the inner corner of the orbit, just behind the inner corner of the lids. It is a hollow, membranous sac, of oval shape, about two-fifths of an inch long, and one-sixth of an inch wide. Below, it opens into the nasal duct. (Fig. 57.)

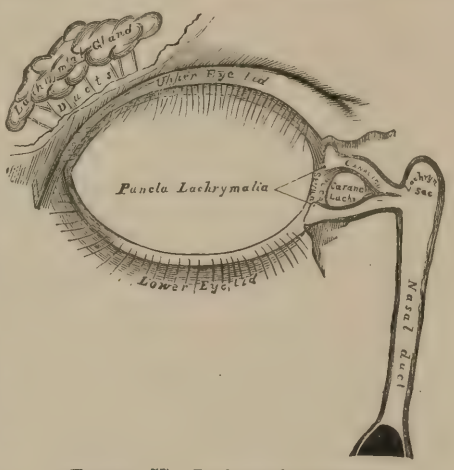

FIGURE 57.—Lachrymal apparatus.

The nasal duct is a bony canal, lined by mucous membrane, and running from the lachrymal sac downward, to empty into the lower part of the nose. It is three-quarters to four-fifths of an inch long, and about one-eighth of an inch in diameter. (Fig. 57.)

The *tears* consist of water containing a little salt and albumen. They are formed in the lachrymal glands, from which they escape by the little openings in the upper conjunctival fold (page 231). They are constantly spread over the front of the eyeball by the winking of the lids, and serve to keep it moist and lubricated. If deprived of this moisture the cornea would become dull and opaque. Any

excess of tears finds its way to the inner corner of the lids, and is taken up by the puncta, and so passes through the canaliculi, sac, and duct, into the nose. Aside from the usual flow of tears, there is a special flow of them caused by any irritation of the eye, or by certain mental states, as of grief. If a particle of dust flies into the eye, there is an extra flow of tears at once, and this tends to wash the foreign substance out again before it can do harm. The tears occasioned by irritation, grief, etc., are so abundant, that they may be felt running down into the nose, and those which cannot escape in this way flow over the cheek. Under ordinary circumstances, most of the tears evaporate, scarcely any passing into the nose. If the secretion of tears were entirely suspended, the resulting dryness of the eyeball would lead ultimately to its destruction for purposes of vision.

The *eyebrows*, or *supercilia* (Latin, *supercilium*, an eyebrow), are the arched elevations of skin and underlying tissue around the upper edges of the orbits. They are covered by a row of short hairs, which are directed toward the temples. They serve to protect the eyes, shielding them from bright light, from the perspiration of the forehead, etc.

After the foregoing general sketch of the anatomy of the eye the reader will more readily understand a few remarks upon *vision*.

THE PHENOMENA OF VISION.

The eyeball is often compared to a photographer's camera, and the comparison is a very just and convenient one. It is essentially a hollow, spherical box, filled with fluids, having its interior surfaces darkened by black pigment, and containing a system of lenses by which images can be formed, and a screen upon which they can be received. In front is a diaphragm (the *iris*), with a variable central aperture (the *pupil*) to regulate the amount of light admitted. All this is much like the apparatus used in taking a photograph. Some recent investigations might tempt us to push the comparison still further. Franz Boll, of Rome, Italy, has found that the layer of rods and cones of the retina (page 227) possesses a beautiful purplish coloring, which is destroyed by the action of light upon it, and constantly renewed again (during life) from the layer of pigmented cells beneath. This coloring is called *the purple of the retina*, or *the sight-purple*. Kühne, of Heidelberg, has investigated this subject very thoroughly, and has performed many experiments upon it, of which the following will serve as an example: A rabbit was placed a short distance from a window and its head covered with a black cloth. The cloth was then removed and

the rabbit's eye exposed to the light of midday for a few minutes. The animal was then beheaded, and the eye removed and preserved, with the usual precautions. On taking out the retina, it was found to exhibit an accurate photograph of the window, its panes white, and its sashes purplish-red. Many other experiments gave similar results. From all this we might conclude that the retina is a sensitized plate, placed at the back of the eye, like that which the photographer slips into his camera before taking a picture; that the sensitive surface of the plate (*the sight-purple*) is worn out by the action of light in forming the images, and constantly renewed again by the wonderful chemistry of the body; that the eyeball is not only like a camera obscura, but like a complete photographic establishment. At present, however, such conclusions would be premature, for the facts regarding the retinal purple are not fully determined, especially in the human eye; and, although the experiments upon it have given such striking results, it is not yet proven to be essential to sight.

Although the eye contains only one *lens* so-called, yet the cornea and the aqueous and vitreous humors also bend the rays of light passing through them, and thus there is really a series of convex surfaces, which together form a compound, convex lens. These are technically called *the refracting surfaces of the eye.* It is very convenient, in description, to speak of *the lens of the eye,* and the expression is proper enough if the above facts are only borne in mind.

Now, as is well known, convex lenses have the power of causing the rays of light which pass through them to converge to a point, or *to come to a focus,* as it is called. It is on this account that they are able to form *images* of objects. Place a lighted candle a few feet from a white wall, and hold a strong convex lens * vertically, in a direct line with the flame and between it and the wall. Then move the lens backward and forward in a line with the flame, and a point will be found where a distinct image of the flame will be formed upon the wall. An image can be formed of any luminous object in the same way. The image will be found to be smaller than the object, and upside down. The image is formed, because the rays of light coming from every point of the object are made to unite in corresponding points behind the lens by passing through the latter. The image is inverted, because the rays, in passing through the lens, cross each other—that is, those coming from the top of the object go to the bottom of the image, etc. (See Fig. 58.)

* One of three or four inches focus.

Now, the rays of light which enter the eye from external objects are converged by its compound lens in exactly the same manner. All that is required to produce a clear image on the screen (or retina) at the back of the eye, is to have the proper relative distances between the object, the lens, and the retina, just as in the case of the candle, the glass lens, and the wall. In the normal eye these conditions are fulfilled in the act of vision. By laying bare the retina at the back part of the eye in animals, experimenters have seen the inverted images of external objects formed there

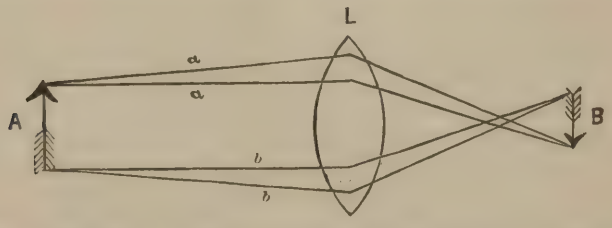

FIGURE 58.—L, the lens; A, object; *aa*, *bb*, rays of light from two points of object; B, image.

Returning to the experiment with the candle: as soon as the image on the wall is distinct, fix the lens in its position. Then, if the candle-flame is moved—if, for instance, it is carried nearer to the lens—the image on the wall will immediately become blurred. To get a distinct image again under these new conditions, the lens must be moved to another point, or must be replaced by one of different power. In the camera obscura the lens can be moved back and forth, so as to form a clear image, whatever the distance of the object. In the eye, however, the distance between the lens and the retina (the retina here representing the white wall in the experiment) may be said to be unalterable. Hence, as the eye is required to see objects at all distances, it must possess the faculty of changing the strength of its lens accordingly. Without this faculty, the image on the retina could be distinct only within very

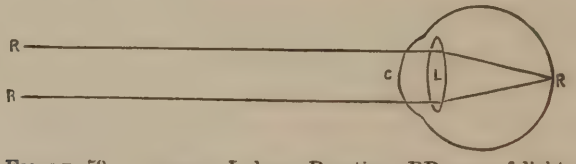

FIGURE 59.—*c*, cornea; L, lens; R, retina; RR, rays of light.

narrow limits. The eye really has this power, called its *power of adjustment*, or of *accommodation*. It is required chiefly for vision of objects at short distances. As soon as objects are brought near

to the eye, the rays of light from them become more divergent, so that they cannot be brought to a focus by the lens so quickly.

Fig. 59 represents two rays of light entering the eye from a given point of a distant object.* It will be seen that they are united in a point exactly on the retina.

Fig. 60 represents two rays coming from a point of a near object. It will be seen that they are more divergent. Hence, they cannot be brought to a focus so quickly. If not interrupted in

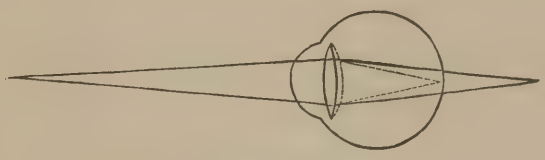

FIGURE 60.

their course, they would be united in a point behind the retina, as shown in the figure. In order to unite these rays on the retina, the lens must become thicker—that is, its converging power must be increased. This is actually done through the faculty of *accommodation*, and this is what that term means. The change is shown in the figure by the dotted lines. The nearer the object, the more divergent the rays from it, and the thicker must the lens become to keep the focus in the retina. As the object recedes from the eye, the lens must become weaker again, which it does by becoming flatter—less strongly curved. All these changes in the lens are accomplished through the action of the ciliary muscle, which is the muscle of accommodation; and they take place usually without any conscious effort on our part. During the act of accommodation the pupil contracts, so that the diverging rays from the near object are allowed to pass only through the central part of the lens, and thus the image on the retina is more distinct than it would be otherwise.† If one looks at his own eye in a mirror, and brings the mirror gradually nearer to his eye, he will see this contraction of the pupil take place.

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* In the ideal eye the distance between the lens and the retina is such that rays of light, which are parallel when they enter the eye, are exactly focussed in the retina. It is found that all rays from distances greater than twenty feet are so slightly divergent that they may be regarded as practically parallel. Hence, the perfect eye sees objects at all such distances without the use of its faculty of accommodation. This form of eye is comparatively rare.

† Because the spherical aberration of the lens is thus lessened. The lens is so constructed that its density decreases from the centre toward the periphery, and this also tends to lessen its spherical aberration.

In describing the retina (page 226), it was shown that the macula lutea, or yellow spot, was the most sensitive part of it, both as regards light and color, and the part always directed toward the object of sight—*the centre of direct vision*, as it is called.*

A single trial will show that, in looking at an object, only a small part of it is seen *distinctly* at one time. The surrounding parts are seen, but they appear blurred. This is because the image of these parts falls on portions outside of this most sensitive point—the macula. (See page 227.) Hold the accompanying circle (Fig. 61) about eight inches away, and look at it with one eye, the other being closed. It will be found that the words in the centre and the words in the margin cannot be read *at the same instant*. When the words in the centre can be seen *with perfect clearness*, those in the margin will appear blurred.

FIGURE 61.

As a compensation for this limitation of distinct vision, the eyeballs can be rotated by their muscles in every direction, so as to command a very extensive field of view. These movements are so rapid and so habitual, that most persons are not aware of the limitation named.

Impressions on the retina have a certain *duration*, which is estimated to be about one-third of a second. Many familiar experiments illustrate this fact. A lighted torch, revolved rapidly before the eye, gives the impression of a continuous circle of fire. In a rapidly revolving wheel, the spokes cannot be distinguished from each other. This duration of the impressions prevents vision from being interrupted by the winking of the lids.

The *color* of light is considered to be analogous to the *pitch* of sound. As the latter is determined by the number of vibrations of the atmosphere which strike the ear in a second, so the former depends on the number of waves of ether which strike the retina in a second. The lowest note of an ordinary musical scale has sixteen vibrations per second; the highest has 20,000 per second. The number of ether-waves which strikes the retina *in a second* to produce the sensation of red (which lies at the bottom, so to

* An imaginary straight line, drawn through the refractive centre of the eye, from the yellow spot to the point looked at, is called the *visual line*, or the *visual axis*. It does not coincide with the optic axis (page 222), and must not be confounded with it.

speak, of our color-scale), is estimated at 474,439,680,000,000. The number required to cause the sensation of violet, which lies at the other extreme of our color-perception, is estimated at 699,000,000,000,000 *per second!*

The two eyes move in harmony with each other in such a way that the macula lutea of each retina is always directed to the point looked at—that is, the two visual lines meet in that point. An idea of these movements may be gained by watching another look at an object as it is approximated to the eyes. As the object is brought nearer, the eyes are turned in toward each other (or *converged*) more and more, so as to keep the two visual lines always directed to the point looked at, and thereby to cause an image always to fall on each macula.

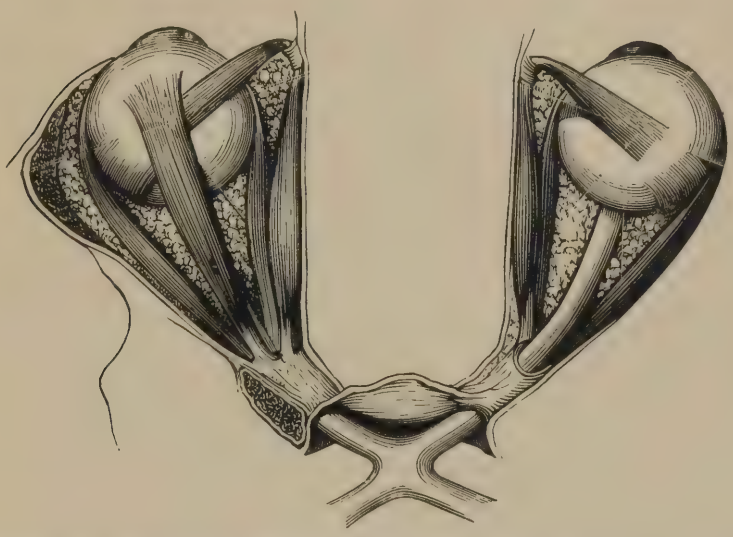


FIGURE 62.—Diagram of the eyes as seen from above, showing the muscular apparatus by means of which they are directed toward the same object.

It thus appears that in ordinary vision with both eyes, there is an inverted image of the object formed at the macula lutea of each retina. By means of the optic nerves, the impressions which these two inverted images make upon the retinæ are conveyed to the brain, and thence results a visual perception, the object appearing to us *single* and *erect*.

If one of the eyes is turned so that its macula lutea is not directed to the same point as that of the other eye, the two retinal images will not be united as usual, and the object will appear doubled. This double vision can very easily be caused if, when

looking at an object with both eyes, one of the eyes is made to deviate a little from its proper position by pressing against it with the finger—as by pushing it upward by pressure through the lower lid.

The phenomenon of single, erect vision from the two inverted retinal images has occasioned much discussion. Scientists have given explanations of it which seem plausible enough, but it can hardly be said that the matter is thoroughly understood. In speaking of the perception of *images* on the retina, it must be remembered that there is no proof that the mind takes cognizance of them, *as such*. We can only say that vision is the result of an irritation of the nerves of the special sense of sight, as hearing, smell, etc., are due to irritations of other special nerves. Whatever we may know of the formation of images on the retina, and of the changes which they excite there, the perception of these impressions by the brain must still seem mysterious to us.

It is a curious fact that sensations of light and of luminous objects can be excited where no light enters the eye, as by blows upon the eye, and by certain irritations in eyes which are totally blind.

In looking at an object near enough to require convergence of the eyes, the image of each eye differs considerably from that of its fellow. This can be readily seen by looking at a near object, and covering each eye alternately. The right eye will see more of the right side of the object, and the left eye more of the left side. It is the combination of these two different impressions that gives us our ideas of *solidity* and *depth*—what is called *the stereoscopic effect*. Otherwise, objects would appear unduly flat to us.

The muscular efforts required to direct both visual lines toward an object, and to see it distinctly, are the chief factors from which we unconsciously estimate the *distance* of an object. This is largely a matter of education and experience. If only one eye is used, it will be found much more difficult to judge of distance correctly.

In the brief outline of the physiology of vision given above, the writer has attempted to set forth only the leading facts in a clear and simple way. Many points connected with the subject have been left unmentioned, and some of them are of great interest. The reader who wishes to study the matter further, is referred to the standard text-books.

Considered as a mere optical instrument, the eye has several imperfections, which cannot be described here. It is admirably adapted, however, to the purposes for which it is designed, and is one of the most wonderful and beautiful organs of the body.

EDWARD T. ELY, M.D.

GENERAL REMARKS UPON THE CARE OF THE EYES.

In the section upon Diseases of the Eye, the writer has attempted to so describe them, that in case of the absence of competent medical advice, the reader may at least do no harm when compelled to undertake the care of these affections. He has also incidentally spoken of the precautions necessary to prevent sound eyes from becoming diseased. It may, perhaps, be well to preface the discussion of the latter subject with some general remarks, which may serve as a guide to parents and teachers, and to all those who have the responsibility of preventing injury to the vision of those under their charge.

Tired Eyes.

There is a popular notion that it is much more dangerous to tire the eyes by use than it is to tire any other organ of the body. It is not necessarily injurious to the legs, or the arms, or the brain to become tired, for proper rest may restore all these to their normal condition. The same is true in regard to the eyes. Proof-readers, sewing women, authors, and mechanics, who use their eyes for a long time upon near objects, must of necessity weary the muscles which adjust the eye to vision ; but if the weariness is compensated for by rest at proper intervals, there will be no harm done to the eyes, for they are so constructed that they can bear maximum fatigue as well as other parts of the body. Education would cease, all mechanical work would soon have an end, if the eyes of school-children and of a certain kind of workmen were never tired. Eyes are never overworked, even if they feel very tired when the task is done, if their natural power and freshness return after the proper intervals of rest during the day and sleep at night.

The Care of the Eyes in Childhood.

The eyes of children need more care than those of adults. As a general principle, intervals of rest between hours of close occupation with the eyes should be oftener and longer in children than in grown persons. The reason of this is, that the eyes of children are still in the course of development, and any organ which is yet to attain its full growth, requires more care in its use, longer and more frequent intervals of rest than one which has already reached its full size.

In a subsequent section I have dwelt at great length on the use of spectacles, and I need only say here that children whose eyes are not diseased, but which require glasses, should not abstain from using them, but should be provided with suitable spectacles, and then go on with their studies. Some of the most successful men and women the world has ever seen, have been successful from the knowledge obtained by the aid of glasses. The eye that needs a glass is not necessarily very much weaker—that is, much less capable of endurance—than one that does not.

Quality, Quantity, and the Point of Admission of Light.

All persons, whether young or old, should take great care with reference to the quality, and the point of admission of the light upon the object to be illuminated. Right-handed persons, if they sit with their right side toward the window while writing, reading, or sewing, necessarily obstruct much of the light which should fall upon the printed or manuscript page or work which is before them. For that reason, persons who use their eyes at work should endeavor, if right-handed, to have the light fall upon their left side, so that none of it will be obstructed by the right arm; and for left-handed persons the situation should be reversed. A light that is in front of the worker is injurious, because it is dazzling. For the same reason, and also because the quantity is insufficient, a light over the head is injurious. Under all ordinary circumstances, light falling upon the side is the best.

Then there should be plenty of light. Reading in the twilight, reading by insufficient illumination, or by a flickering gaslight, produces injurious effects upon the eyes. It causes a strain on the muscles for exact vision. All strain that is continued for any considerable length of time is reflected injuriously upon the blood-vessels of the eye, and if upon the blood-vessels, it is upon what physicians call the nutrition of the eye—upon its health—for the blood-vessels are the great sources of repair of waste of tissue.

The Character of Type.

The character of type should be carefully considered, and parents and teachers should see to it that books which are printed from old and much worn plates, or with very small type, are rejected. Books abounding in fine foot-notes should not be used in schools. Books printed in the Greek language should be very carefully executed. This is also true of German text. It would, indeed, be a benefit to the world if the Germans would give up

their absurd characters and use the Latin ones, which are employed by English, American, French, and many other nations. The reason, of course, for avoiding type of this kind, which is not accurately and clearly formed, is that the effort necessary to see the words distinctly causes a strain upon the muscle inside of the eye, described on page 237, which adapts it to vision. A moderately wide page is less tiresome to the eyes than a very narrow one, because the changes in the position of the eyes are not so frequent in reading from broad pages as they are in reading from very narrow columns.

School-Houses.

The builders of school-houses have a great responsibility in arranging the desks for the pupils. The principle, as to light, which has just been laid down, should be carefully held in view. For, as I have said, it is the eye which is in the process of development that is peculiarly liable to be affected by improper or defective light. It is just as easy to arrange the desks so that the light comes in from the left side of the student as it is to place them otherwise.

FIGURE 63. — School-desk, showing the proper position for the book. The seat should be so arranged that the head need not be bent over, in order that the scholar may see distinctly.

The height of the desk is also important.* A short-sighted child should not be permitted to bend over his or her book. Indeed, no person should. It would be very well if, in large and well-regulated schools, there were a certain proportion of standing-desks to which pupils might be sent, in order to relieve their eyes from strain when bending their heads. At any rate, the head should never be bent so much that entrance of blood into the eye is very much favored, while its return is hindered. So far as possible the head should be kept in an erect position, in a line with the trunk, while study or any other close work with the eye is carried on.

The managers of country school-houses might so arrange things

* [The desk here represented is of English manufacture, and is arranged so that the back-rest may be adapted to different heights, and the seat may be raised or lowered or made to approach or recede from the desk, as the size of the occupant may require. —ED.]

that the grateful shade of trees could be near the windows, and thus temper the glare of the sun in summer and of the snow in winter. It is surprising that the common advantages of country life are not made more complete use of. A few trees, not too near the windows of a school-house, would be of great service to the eyes of the little students.

Atmospheric Conditions.

An atmosphere laden with smoke not only renders reading difficult, but is, of course, detrimental to the general condition of the eyes. It is much worse to attempt to read or sew in a smoky atmosphere than to be quiet, without occupation of the eyes, in the same locality.

Riding or driving in a very strong wind is sometimes very dangerous, at least for eyes which are inclined to any kind of congestion. Many accidents have been caused by the wind striking forcibly upon the delicate structure of the eye. For, it is to be remembered, that the invisible wind has a power which is as severe as a blow from a tangible object, and it may injure blood-vessels so as to give rise to bleeding from them that will do the eyes great harm. If obliged to ride or drive against a strong wind, most persons will do well to wear blue or smoke-colored glasses as a protection against its direct force. Men should at least wear broad-brimmed hats. It need hardly be said that acrid vapors of all kinds are injurious to the delicate structure of the eye, and every person should avoid them as carefully as he would refrain from keeping his eyes wide open in a dust-laden atmosphere. Broad-brimmed hats are a great protection from such influences as those just mentioned, as well as from the glare of the sun, especially in cities where it is reflected from the pavement so as to be extremely unpleasant.

Travellers in mountainous regions, where snow perhaps may lie and reflect the light injuriously, should also wear these protective glasses. Goggles, or glasses set in cases made of wire network, as has been said in the section relating to the different diseases of the eyes, are not suitable, because they keep the eyes too warm, and, although they afford protection, they tend to excite the very diseases they are designed to avert.

The light reflected from snow is a fertile source of injury to the eyes. Boys and girls while coasting, should have their eyes protected, the one by caps with broad visors, the other by hoods projecting a little in front of the face.

Reading in Railway Trains.

Thousands of people living in places which compel them to travel in the railway trains to and from cities in pursuit of their daily occupation, are exposed to injurious effects upon their eyes, from the fact that the railway carriages go rapidly through different kinds of light, and roll so unevenly that the object looked upon, such as a newspaper or book, cannot be held steadily. In order to see distinctly in a moving railway carriage, the eyes must act spasmodically, or, at any rate, change their focus often, and hence a constant strain of the muscles of the eye is produced. If people are wise enough to stop when they find their eyes fatigued, it is probable that much reading can be done in this manner without positive injury; but if they continue to read after fatigue and discomfort are experienced, they may expect most serious consequences.

Reading in Bed.

Reading in bed is apt to be injurious from a variety of causes. The position is usually nearly flat on the back, which is a bad one for reading, and the light is apt to be insufficient and inconvenient. Invalids are most apt to read in bed. Fatigue of the muscles of the eye is, of course, more easily induced in them than in strong persons. Women reclining during the menstrual period, or in the days after childbirth, should be especially careful. Children recovering from measles and scarlet fever, should be especially guarded against using their eyes with small toys, or by reading or writing when they are not fully well, and especially when they are not yet allowed out of bed.

The invalids most apt to be injuriously affected by use of the eyes upon near and fine objects, are those who have lost much blood, and who are weak from this cause, or who suffer from certain affections of the brain. These two classes of sick persons, even if they are up and about, should be guarded against any long-continued use of the eyes upon objects that must be held near them in order to see them distinctly, and from reading that which requires any considerable mental exertion.

Training the Eye to look at Distant Objects.

Those who have the care of young children and youth should give much attention to this subject, and practise their charges in looking at long distances. Shooting, archery, and the like amusements become valuable means for training eyes for distant vision,

and thus of preventing or lessening the elongation of the eyeball, which is the cause of near-sightedness. Such sports are as necessary for the development of eyes as are the common ones of ball-playing, cricket, hoople, and so forth, for the development of the legs and arms. It is probable that the immunity from near-sightedness which the British people enjoy as compared with the German nations, is due to the variety of out-of-door life which the former encourage in their young and old people.

Reading Music.

Those who read music are particularly liable to strain of the eyes, because exact vision is required to follow the notes. Persons who should wear glasses for reading will especially need them while reading music, and a particularly good light is necessary to avoid straining the eyes.

Blurring of Vision.

Those who are inclined to overrate their symptoms are especially liable to do so with reference to their eyes. Any reader, with the opinion that fatigue of the eyes is very dangerous, and who becomes anxious with regard to the condition of his or her eyes, may sometimes have his equanimity restored until proper authority can be consulted, by testing the fact as to whether the finest print can be seen distinctly, if even for only a few seconds. If it can be distinctly made out, even though it causes fatigue, the presumption is that the weakness of vision depends upon some cause which can be removed. In these cases it is not so much a loss of the power of seeing that has occurred, as of the ability to continue to use the eyes. Blurring of the sight, therefore, in cases in which distinct vision exists for a few seconds, is by no means so dangerous a symptom as the absolute inability to see small objects. The latter is always a warning to immediately seek good medical advice. The line must, therefore, be carefully drawn between tired eyes and eyes which are absolutely unable to see fine objects —to *make out*, as we say, very fine print or the like.

Oculists call the former condition weak sight, and the latter loss of sight. Glasses will often remedy weak sight, while they will do no good for loss of sight from disease.

Pain in the Eyeball.

What has been said with reference to blurring of vision, may also be said of pain referred to the eyeball. If such pain is less after rest of the eyes; if it is, for instance, less in the morning after a night's sleep; if it is *not attended by positive loss of vision*, it is probably like blurring, one of the symptoms of over-work of the eyes, or use of the eyes under improper conditions, such as the neglect of wearing glasses for correcting and improving the vision when they should be worn, or of their use with insufficient illumination, or an incorrect position of the body, and so forth.

Loss of Sight.

It is strange that many persons will allow their power of seeing to slip away from them without alarm, when they are actually unable to see objects which, a week before, they could see distinctly.

Every person who suspects serious trouble with his eyes, should test himself by objects of a kind and size, which he knows that he has formerly seen distinctly at a given distance, and if he finds that he cannot see those objects, he should certainly seek advice. But as has been said, mere pain, or mere blurring, without actual loss of vision, are not symptoms of as alarming a character as this inability to see certain objects that formerly were distinctly made out. The writer, in common with all medical men who see much of diseases of the eye, has seen so many cases of such marked self-deception in regard to the loss of sight, that he is unable to trust the patients' own opinions with regard to their visual power, but is always compelled to resort to an exact examination by means of so-called test-letters.

Test-Letters.

Oculists, for the purpose of testing the visual power of their patients, use a series of sentences, which begin with the finest type that is made, and increase in regular order until very large or coarse type is used. A specimen of these is given on the following pages. Besides, they also employ a series of single letters. The latter is a more valuable test. If the letters that are used at the bottom of page 249 can be distinctly seen at a distance of twenty feet, there can hardly be any loss of sight. If it cannot be, the patient may

simply require glasses. But if the finest print, of which the specimens are given on this page (No. 1), cannot be read at any distance or with any light, there is certainly some loss of normal vision. If it can be read fluently and yet there is fatigue afterward, it is probable that the affection, if any exist, can be relieved by glasses or by general treatment. If the finest type can be fluently read, but only when held nearer than six inches, it is probable that the patient is short-sighted, especially if the test-letters cannot be seen at twenty feet distance. If the patient hold the test-sentence "No. 1" farther than eight inches from his eye in order to read it, it is probable that he is far-sighted, especially if he can read the test-letters at twenty feet. The important facts to be remembered are:

I. That an ability to read the test-letters fluently when placed at a distance of twenty feet, and "No. 1" at eight inches, constitute normal vision.

II. Inability to read the letters at twenty feet, while "No. 1" of the test-sentences can be fluently read at a distance less than six inches, indicates short-sightedness.

III. Ability to read the letters at twenty feet, while the test-letters "No 1" cannot be read at all, or only when held more than eight inches from the eye, indicates far-sightedness.

IV. Ability to read both the letters and the sentences at the proper distance, followed by a sense of strain, means weakness of vision.

V. Inability to read either the letters at twenty feet, or the sentence "No. 1" at any distance, means loss of sight by disease. This loss may be estimated by noting the distance at which the letters may be made out, if at all, and the number of the test-sentences that can be read.

Jaeger's Test-Types.

No. 1.

When, in the course of human events, it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume, among the powers of the earth, the separate and equal situation to which the laws of nature, and of nature's God entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation.

We hold these truths to be self-evident—that all men are created equal; that they are endowed by their Creator with certain inalienable rights; that among these are life, liberty, and the pursuit of happiness. That, to secure these rights, governments are instituted among men, deriving their just powers from the consent of the governed; that, whenever any form of government becomes destructive of these

No. 2.

ends, it is the right of the people to alter or abolish it, and to institute a new government, laying its foundations on such principles, and organizing its powers in such form, as to them shall seem most likely to effect their safety and happiness. Prudence, indeed, will dictate that governments long established should not be changed for light and transient causes; and, accordingly, all experience hath shown that mankind are more disposed to suffer, while evils are sufferable, than to right themselves by abolishing the forms to which they are accustomed. But when a long train of abuses and usurpations, pursuing invariably the same object, evinces a design to reduce them under absolute despotism, it is their right, it is their duty, to throw off such government, and to provide new guards for their future security. Such has been the patient sufferance of these Colonies, and such is now the necessity which constrains them to alter their former

No. 3.

systems of government. The history of the present King of Great Britain, is a history of repeated injuries and usurpations, all having in direct object the establishment of an absolute tyranny over these States. To prove this, let facts be submitted to a candid world.

He has refused his assent to laws the most wholesome and necessary for the public good.

He has forbidden his governors to pass laws of immediate and pressing importance, unless suspended in their operations till his assent should be obtained; and, when so suspended, he has utterly neglected to attend to them.

No. 4.

He has refused to pass other laws for the accommodation of large districts of people, unless those people would relinquish the right of representation in the Legislature—a right inestimable to them, and formidable to tyrants only.

He has called together legislative bodies at places unusual, uncomfortable, and distant from the repository of their public records, for the sole purpose of fatiguing them into compliance with his measures.

He has dissolved representative houses repeatedly, for opposing, with manly firmness, his invasions on the rights of the people.

No. 5.

He has refused, for a long time after such dissolutions, to cause others to be elected, whereby the legislative powers, incapable of annihilation, have returned to the people at large for their exercise; the State remaining, in the meantime, exposed to all the dangers of invasions from without, and convulsions from within.

He has endeavored to prevent the population of these States; for that purpose obstructing the laws for the naturalization of foreigners; refusing to pass others to encourage their migration hither, and raising the conditions of new appropriations of lands.

No. 6.

He has obstructed the administration of justice, by refusing his assent to laws for establishing judiciary powers. He has made judges dependent on his will alone for the tenure of their offices, and the amount and payment of their salaries. He has erected a multitude of new offices, and sent hither swarms of officers to harass our people and eat out our substance. He has kept among us in times of peace, standing armies, without the consent of our legislatures. He has affected to render the military independent

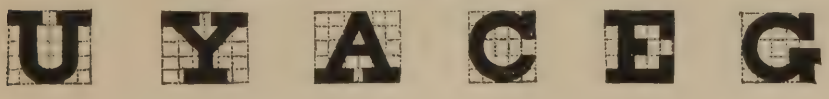
No. 7.

of, and superior to the civil power. He has combined with others to subject us to a jurisdiction foreign to our constitutions, and unacknowledged by our laws, giving his assent to their acts of pretended legislation. For quartering large bodies of armed troops among us; for protecting them, by a mock trial, from punishment for any murders which they should commit on the inhabitants of these States; for cutting off our trade with all parts of the world; for imposing taxes on us without our

No. 8.

consent; for depriving us, in many cases, of the benefit of trial by jury; for transporting us beyond seas, to be tried for pretended offences; for abolishing the free system of English laws in a neighboring province, establishing therein an arbitrary government, and enlarging its boundaries, so as to render it at once an example and fit instrument for introducing the same absolute rule into these colonies; for taking away our charters, abolishing our most

Snellen's Test-Type. (No. 20.)



Floating Bodies before the Eyes of Persons with Good Vision.

Many persons are very much alarmed by the appearance in their field of vision, especially when looking toward the sky, but sometimes when looking upon the printed page, of objects somewhat like little rings of mucus or minute soap-bubbles. Many of these appearances are merely shadows cast upon the retina. These shadows are the result of a disturbed condition of the natural component parts of the vitreous humor. (See p. 228.) They are not dangerous; cannot be seen by the physician when he looks into the eye with the ophthalmoscope, and they are seen most frequently in the eyes of those persons who use their eyes continuously. Other floating bodies in the vitreous, which are really dangerous, may always be seen by the aid of the ophthalmoscope, and neither improved condition of the general health, nor increase of the general strength, will ever cause them to disappear. They consist of blood and coloring matter which have escaped into the vitreous as the result of severe inflammation of the back part of the eye.

The former are found in persons who see perfectly well, but who are somewhat annoyed by the appearance of the rings while at work. Such persons may, perhaps, be quieted by the assurance that if, in spite of such annoyance, they see distinctly throughout the entire field of vision, and if they can read the finest print, and no loss of the power of seeing objects at a distance has occurred, they need have no apprehension as to serious consequences resulting from them.

Influence upon the Eye produced by Habits of Life.

The habits of life influence the eyes very markedly. Not always, but in a large proportion of cases, men who smoke and drink habitually and excessively are very apt to suffer, not only from inflammation of the outer part of the eyes, but from more serious forms of disease of the nerve and the retina. The person who is intemperate in smoking or drinking will suffer from his eyes exactly as in other organs of his body. These habits cannot be indulged in with impunity, and because some people go through life almost as inebriates, and yet do not suffer as to their eyes, is no more an argument that these habits are not generally injurious, than it would be to say that war is not dangerous because many people have passed through severe battles without losing their lives. Excessive indulgence in venery, whether among the mar-

ried or the unmarried, is sometimes a source of muscular fatigue, and consequently of congestion of the eyes.

It should always be remembered that eyes are only—eyes. Men and women must not expect to be able to live on insufficient food, and labor twelve or fourteen hours daily, with scarcely any interruption, without sooner or later reaching the point at which their eyes are unable to do their work. There is no organ in the body which requires more attention to the general health, the condition of the skin, exercise in the open air, good food and proper habits in every respect, than the eye. The tissues of this organ are peculiarly sensitive to any general influence.

The constitutional diseases may and do often affect the eye. This subject has been fully discussed in the following sections. Such diseases are, measles, scarlet fever, small-pox, yellow fever, syphilis, rheumatism, diphtheria, lead-poisoning, and so forth.

Length of Time that Eyes may be Continuously Used.

It is very hard, if not impossible, to lay down exact rules on this point. Perhaps, however, it may be correctly said that children under seven years of age should not be forced to use their eyes continuously on small objects held near them, longer than a few minutes at a time. In short, they should not go to school before that age, unless it be that they may be permitted, after six years of age, to be taught by object-teaching, by the so-called *Kindergarten* system.

Between seven and fourteen, children should not use their eyes at reading, writing, sewing, and so forth, more than three hours a day. The time spent in reciting is not included in this. Young men and young women between the ages of fourteen and twenty-one ought to be able to learn all their lessons, write all their essays, practise all their music in a period of five hours a day for five days out of the seven. Correct habits of study, that is to say, earnest attention to the work in hand, without dawdling, will certainly enable most youth of ordinary capabilities to do all their hard study in less than five hours a day. As to grown men and women, it is well-nigh impossible, in the light of present knowledge, to correctly name the time that may be daily spent in the use of the eyes on near and small objects. Experience as to one's own capabilities, if regarded, will soon settle this question.

GENERAL REMARKS UPON THE CARE OF INFLAMED AND INJURED EYES.

In the various sections of the chapter upon the Diseases and Injuries of the Eye, a detailed account is given of the general rules of treatment, but a very few general remarks on the same subject may not be out of place here.

Darkening of Rooms.

One of the common mistakes of those who have not had much to do with the care of the eyes, is to say that inflamed or injured eyes often require a confinement in a dark room for a longer time than a few days. Whatever is necessary in the way of exclusion of light, except after surgical operations upon the eye, and in a limited number of cases of disease, can be attained by the use of light bandages or protective colored glasses.

The writer has seen several persons who have been very unwisely kept for months and years in very dark rooms on account of trouble with their eyes. There are no circumstances which will justify any such exclusion of light as this. The influence of the sun and the fresh air are just as necessary to the body when the patient is suffering from disease of the eyes, as when affected with disease of the lungs, and we must look with suspicion upon any advice which contemplates keeping any patient with an affection of the eyes in a very dark room for a long period of time. Light is the true stimulus of the eye, and even diseased eyes, in a large proportion of cases, are the better for this stimulus, the same as an injured limb at a certain stage of its recovery is the better for gentle, active, or passive exercise.

The writer has seen ludicrous instances of the confinement of patients suffering from trifling injuries and diseases of the eyes, in rooms from which every beam of light has been rigorously excluded, and he has also seen the sad ones, already alluded to, where the general health has been seriously undermined, by prolonged exclusion of the light from the eyes of patients who should have been allowed to go about in the air and sunlight.

Poultices and other Applications.

Any person who prescribes for an eye without a knowledge of its anatomy, incurs a serious responsibility. Yet thousands of people take this responsibility lightly upon themselves. One of the most dangerous remedies thus prescribed is a poultice.

Poultices have destroyed so many eyes that, although their baneful influence has been alluded to in discussing the different diseases of the eye, I must here speak of them. Poultices usually quiet pain, but their beneficial effect in this way is more than counterbalanced by their dangerous power of softening the delicate tissues to which they are applied. In case of doubt regarding an affection of the eyes, it is much better to be content with the simple rules for keeping them clean, for keeping them from the influence of dust, wind, smoke, and the like, and bathing them with cold or lukewarm water, at intervals, and then do nothing more. It is better, I say, to follow these rules than to run any risk by using any wash or application, no matter how beneficial it may seem to have been in some other cases.

When severe pain is experienced in the eyes, very hot water may be applied for five or ten minutes every hour or so, without danger. It should be used by "sopping" the eyes with very soft cloth which has been dipped in almost boiling water. The continuous application of moist heat to the eyes is very dangerous, because the transparent and very delicate front of the eye may be broken down by its application.

Cold water is often grateful and necessary for inflamed eyes. It may be applied continuously, if it is agreeable, but great care should be taken that it is not allowed to become warm upon the eyes. To avoid this, bits of soft cloth may be laid upon a block of ice and then upon the eyes. These applications should be changed every one, two, or three minutes, according to the heat of the eyelids. A "rose" attached to a water-pipe is another means of irrigating the eye with cold water. Douches for the eye that are worked by pressure upon an India-rubber air-bag, are also useful for the same purpose. Plunging the head under water, and then opening the eyes in it, seems a harsh method of washing the eyes. Many persons practise this. The experience of the writer seems to show that it produces no beneficial results that may not be obtained by a less disagreeable and less dangerous method.

Water that is slightly impregnated with salt, in the proportion of a teaspoonful to a quart, is usually a bland and useful application to eyes that readily redden and become catarrhal.

It is impossible to lay down any rules that will be sufficient for the care of any part of the human frame under all circumstances, but it is hoped that the foregoing will at least serve as a guide to those who may read them, and who are anxious to preserve their vision.

DISEASES OF THE EYE.

THE human eye is subject to numerous diseases, and it is also in quite a large proportion of cases so irregular in shape as to be only completely useful when aided by spectacles. Moreover, the exposures incident to the various employments of adult life, and to the amusements of childhood, very often inflict injuries upon it. It will be the object of this chapter to furnish some general but correct ideas as to the nature and treatment of the affections thus variously produced. For the sake of system and order in our study, the affections of the lids and of the tear apparatus will be first discussed, after which we may pass on to those of the eyeball.

Inflammation of the Edges of the Lids—Blepharitis Ciliaris.

The edges of the lids are sometimes red and covered by a thick secretion which lies in crusts about the roots of the lashes, and on the mouths of the little tubes that are found in the cartilage or dense portion of the lids. This condition of things may be neglected or not properly treated, and may go on to such an extent as to destroy the lashes and give the eyelids a very unsightly appearance. This affection is probably as old as the race. It is particularly liable to occur in hot, dry, and dusty countries.

The Bible describes Leah as "tender-eyed," but says of Rachel that she was beautiful and "well-favored." The "tender" eyes of Leah, judging from what the travellers say of the prevalence of inflammation of the edges of the lid in the East, were affected in the manner that has been described.

Causes.—These are chiefly to be found in a kind of catarrh caused by the presence of irritating substances upon the edges of the lids. Among the poorer classes dirt plays an important part in producing the disease. It is peculiarly apt to occur, as will be seen in the consideration of the use of spectacles, in persons whose eyes require glasses, but who do not wear them. Such eyes are constantly subject to a strain which may be compared to that undergone by any muscles that are working at a disadvantage, and which are attempting to do that for which their power is insufficient.

Treatment.—The necessity for perfect cleanliness of the part involved in the disease, is the first and last advice to be given in all external diseases of the eye in which there is an increase of the natural secretions or any formation of pus. Eyes affected with diseases of the roots of the lashes, or of the glands at the edges of the lids, are best cleansed in the following manner:

A teaspoonful of ordinary baking-soda is dissolved in about a pint of warm water. Then the eye to be washed should be gently closed, and if the patient be a grown person the washing is done with his own hand by means of small bits of an old cambric handkerchief or similar material. If crusts are upon the lids, this washing will require some rubbing, and will cause discomfort. It is not, however, to be desisted from on this account, but it is to be continued until all the crusts are removed. If some of the hairs, or all of them, come out, no harm will result, for they will soon be renewed. If they are ulcerated at their roots to such an extent that they are likely to fall off in a short time, the sooner they come away the better for the cure. After the cleansing has been thoroughly accomplished, some substance, such as vaseline, cold cream, simple cerate, or mutton-suet without salt, should be rubbed, in very small quantity, along the roots of the lashes. This is to prevent the sticking together of the lids—a very unpleasant symptom usually observed on awaking from sleep. The water used in cleansing the lids should be tepid. Breast-milk, cow's milk, and other popular washes for inflamed eyelids have no virtues beyond those of simple water. Their use should not be encouraged.

Severe cases, or those of long standing, may require, after the washing, more energetic treatment, that is, more powerful applications, but these should only be made under the advice of a physician. If the case is one that is aggravated, or maintained by the fact that the patient requires glasses and does not wear them, the eyes must be examined by an oculist, and the proper glasses prescribed.

Styes—Hordeola.

These are essentially small boils at the edges of the lids. They begin in the hair-follicles or in the glands of the cartilage. As is well known, they are apt to occur in rapid succession on the same eye.

Causes.—It is probable that all boils are in some way, not as yet explained, connected with or dependent upon an impairment of the general health, so that patients who are affected with styes should consider them as warnings with reference to some general and worse affection than the one of the eyes. It may be a disordered condition of the digestive apparatus, or impoverishment of the blood, and there may be local causes acting with these.

Symptoms.—A stye appears as a red, usually small swelling at the edge of the lid. It sometimes disappears without breaking,

but more often it suppurates and discharges a small amount of pus, when the pain and tension in the eyelid, which have been considerable, are relieved.

Treatment.—The use of small poultices applied to the parts for a few hours, and then the evacuation of the pus by a knife in the hands of a surgeon, are means of treatment that usually shorten the duration, and alleviate the discomfort of styes. In applying the poultice care should be taken that it be applied to the stye only, and not to the eyeball, for poultices are very dangerous applications to the eye itself. Where styes occur in frequent succession, physicians are sometimes able to abate them by suitable advice and applications.

The use of very small poultices in the stage of swelling and pain, followed up by the application of vaseline, cold cream, mutton-suet without salt, or the like, when the stye has broken, is about all the local treatment that is of service in alleviating its pain and discomfort.

An ointment of the red oxide of mercury, one or two grains to the drachm of simple cerate, is said, when rubbed upon the inflamed part, to sometimes prevent its full development. The writer, however, has more faith in careful attention to the state of the general system, which should be carefully looked into if styes continue to recur. If there be any short-sightedness or other condition of the eye requiring spectacles, these should be properly chosen and worn.

Tumors of the Eyelid—Chalazion.

The eyelids are sometimes affected with small growths that are not dangerous. These tumors are usually the result of a closure of the mouth of the little tubes found in the cartilage of the lid, and described on page 232. When the oily matter formed in these tubes or glands cannot find its way out in the natural way, it extends upon each side and forms quite a lump. The process is as purely mechanical as the distention of any flexible tube from overfilling. It is probably an inflammation at the mouth of the tube, which finally closes it.

Treatment.—These growths sometimes disappear of themselves without any treatment. Sometimes they become so distended as to burst, and for some days considerable disfigurement results. More frequently, however, the opening at the end of the canal is restored, and a cure is effected by the evacuation of the collected material. They often, however, do not disappear for a very long time, and they should then be cut out by a surgeon. The operation

is a simple one, but quite painful, and it is usual to cause the patient to inhale ether when it is performed. All the operations upon the outer parts of the eye are usually more painful than those upon the interior, simply because these parts are more abundantly supplied with nerves of sensation than the other.

Displacement of the Lids Inward or Outward—Entropion and Ectropion.

These deformities of the lids are chiefly produced by two causes : inflammations of the lining membrane of the lids (the conjunctiva), or injuries of the lids themselves. The natural curvature of the lids, as will be seen by a glance at a healthy eye, is admirably and exactly adapted for the protection and comfort of the eyeball. Any curving in or out of these parts produces very considerable discomfort and annoyance. If the lids be turned in, the lashes press upon the delicate structure of the ball, and cause serious inflammation. If they turn out, the carrying off of the tears is interfered with, and the eyeball is exposed to the unpleasant and injurious influence of dust, dirt, the wind and the like.

Treatment.—There are surgical operations for the relief of these affections, which are successful in a good proportion of cases ; but it should be remembered that these are consequences of disease and injuries, and not primary affections, and hence we may not expect the results that are to be obtained when the original affections are treated. Besides, injuries of the lids are sometimes of so destructive a character, that their results are irreparable.

Individual eyelashes are sometimes displaced without any particular curvature of the lids. If their repeated removal does not overcome the faulty disposition, their roots may be destroyed by surgical procedures.

Paralysis of the Muscles of the Eyelids.

All the muscles that move the eye may become unable to do their work. As a rule, however, only one, or a group supplied by the same nerve, is paralyzed. The muscle that lifts the lid is quite often thus affected, and causes what is known as *ptosis* (a falling). In this form of paralysis, the nerve, called by anatomists the third cerebral nerve, one that passes from the base of the brain to this muscle, as well as to four other muscles of the outside of the eye, is the seat of disease or injury at its origin, or in some part of its course.

Causes.—These sometimes act in the womb, and children are born with paralysis of the lids, so that they cannot be opened widely. Injuries and diseases of the brain are also causes. The so-called blood-poisons, such as syphilis, may and do very frequently cause paralysis of the muscles of the lids.

Treatment.—The congenital form of paralysis of the upper lid, and that resulting from injury, may sometimes be benefited to some extent, but generally not entirely cured, by a surgical operation, which shortens the lid and thus relieves the paralyzed muscle of a part of its weight. That caused by the poison of syphilis may often be entirely cured by the treatment appropriate for the constitutional disease.

Paralysis of the Muscle that Shuts the Lid.

The seventh cerebral nerve supplies this muscle (*orbicularis*). It is therefore an affection of this nerve that causes an inability to close the eyes. Inasmuch as the muscle with which the cheek and lips are moved, are also supplied by this nerve, such a paralysis is usually accompanied by a falling down of the angle of the mouth, and an inability to pucker the lips, as in the act of whistling, etc. If the portion of the nerve that supplies sensation to the face is also affected, there is also insensibility as well as loss of motion. (See Paralysis of the Face.) For some unexplained cause syphilis is more apt to attack the third than the seventh nerve.

Exposure of the face to a draught of air, the breaking of a blood-vessel at the origin or in the course of a nerve, inflammations of the neck and face, the excessive use of tobacco, are also well-defined causes of paralysis of this nerve.

Sometimes the disease or injury of the nerve causing the paralysis affects it before it passes out of the skull. Sometimes it is affected in its passage through the drum of the ear, or just after it has come out at the angle of the jaw, or even not until it passes over the face itself.

Treatment.—The treatment is, of course, to be directed toward the cause, and will vary according to this. Paralysis of the nerve from exposure to draughts of air is usually recovered from spontaneously. Electricity and mechanical support are very useful in the care of these affections.

Twitching of the Eyelids.

Involuntary movement of the muscles of the lids is a symptom usually seen in connection with general disease of the nervous system, such as chorea, the so-called St. Vitus's dance. Indeed, it is often a kind of chorea, and the reader is referred to the section upon that subject for fuller information.

Spasmodic Closure of the Lids.

The eyelids are sometimes firmly and spasmodically closed in the course of different affections of the eye. The reason for this closure is either an abnormal sensitiveness to light or great swelling of the lids. This condition is simply a consequence of the affection that causes the dread of light and the swelling. It will be again alluded to in the description of those diseases.

Bruises of the Eyelids.

The eyelids are sometimes injured by blows from the fist, or from some missile which ruptures the blood-vessels, and permits the escape of blood into the loose connective tissue of the lids. The condition is popularly known as a black-and-blue eye. If no parts deeper than the lid be involved, time will soon effect a cure. Cold applications are usually grateful to the eye. It is believed by some that the application of ice-water, evaporating lotions, extract of witch-hazel, or arnica, hasten the absorption of the blood, but this belief is not shared by the writer of this chapter. Iced cloths, applied often enough to always have the eye kept cool, and never warm, are to be urgently recommended, however, in the hours immediately after the injury, since they lessen the heat and swelling. Tradition, among the laity, speaks well of a poultice of raw beef, an oyster, or the like, and they undoubtedly are grateful to the eye ; but such applications are dangerous, especially if kept on for many hours in succession, and ought never to be made, except under close medical observation. They are agreeable to a bruised eyelid, hence their traditional popularity. The disfigurement is so great from a black and blue eye, that in large towns there are artists who remove it by a skilful painting of the discolored parts.*

[* A solution of nitrate of potash in water, applied with muslin cloths, will often change the color from dark to a brighter red.—Ed.]

Wounds of the Lids.

These should be treated at once by a surgeon, so that deformity may be avoided by a skilful bringing together of the divided parts by stitches.

Affections of the Tear Apparatus—Lachrymal Diseases.*

The diseases of the tear-apparatus are quite common in all countries where the climate is variable. In general terms they may be said to be most commonly produced by the same influences as those which cause a cold in the head. The lachrymal gland (see figure on page 233), however, is rarely the seat of disease. The chief troubles of the so-called lachrymal or tear-apparatus are in the conduction or carrying off of the tears. A "weeping eye" is the result of some obstruction in the conducting apparatus. By this term, as is perhaps well known, is meant an eye that is constantly moistened with tears which are not carried off into the nostril, but which run over the cheek. Since these passages are narrow, a slight swelling of their lining membrane is sufficient to impede the passage of the tears. This swelling is generally the result of a cold in the head, or rather of the swelling of the lining membrane of the nostrils and pharynx, which is continuous with that of the tear-passages. This swelling is one of the symptoms of a cold in the head. Another prominent symptom is an increase of the natural secretion of the membrane covering the eye, lining the eyelids and the lachrymal and nasal passages—the conjunctiva. This condition increases the work of the apparatus for carrying off the tears, while the former diminishes the size of the parts through which the tears have to pass. Under the usual treatment for a cold in the head, or, perhaps, with no especial treatment, these symptoms pass away, but it sometimes happens that the cure is not complete, and the passage into the nose from the sac (see figure) is left smaller than is natural, and perhaps, also, the little canal leading into the sac. We then have a narrowing or stricture of the tear-passages. If, added to this, there is an increase in the secretion from the mucous membrane lining the parts, we have catarrh of the tear-passages.

These two conditions are usually united in the same case. The collection of tears in the corner of the eye, and their escape over the cheek are the chief symptoms of a "weeping eye," when the

* Before studying this section, it will be well for the reader to refer to the anatomy of the parts involved, on a preceding page.

disease is of a mild character. There is, however, a form of this trouble in which the mucus collects in such quantities in the sac as to enlarge it and form a tumor or swelling at that point. This may often be emptied by pressing upon the enlarged sac. Many people live for years with such a deformity and inconvenience, with no attempt at relief.

There is danger, when the disease reaches such a point as this, that pus or matter may collect in the sac. We then have to deal with a very painful and serious affection. The formation of pus in the human body is generally ushered in by a chill or, at least, chilly and uncomfortable sensations, and when it occurs in the eyelids or appendages of the eye there is no exception to the rule. The eyelids swell very much at this time, so that it seems as if all the tissues of the parts were involved. A mistake is sometimes made in supposing that a disease of this kind is an attack of erysipelas. A little attention to the history of the previous condition of the tear-passages, and a close examination of the corner of the eye over the sac, will show the real nature of the trouble. This formation of pus is preceded by the ordinary symptoms of what is termed inflammation. These symptoms are heat, redness, swelling, and pain. If the disease be not recognized at an early date and appropriately treated, after some days of intense suffering the pus will make an opening in the skin of the sac and force its way out. Although the patient will get relief from his sufferings, there will be apt to remain a permanent opening in the skin. This opening is called a *fistula*. This condition is worse than the originally existing "weeping eye."

Causes.—The causes of these affections of the tear-passages have, perhaps, been plainly enough indicated in the statement that they are chiefly the result of an inflammation of the mucous membrane lining them, or of a continuation of such an inflammation from the nose and throat to the eye. The causes of catarrh are discussed in another part of this volume.

It is sufficient to say here that all improper habits of life, all diseases which lessen the power of resistance to changes of temperature, may be causes of catarrh. Syphilis is also not infrequently a cause of catarrh of the tear-passages, as well as of catarrh of other mucous membranes.

Treatment.—Probably every observant reader of these pages is able to recall examples in his own acquaintance of the "weeping eye," and he will remember that some of these cases have seemed to go on for years without causing anything more than considerable inconvenience. Inquiry, however, will often elicit the fact that there have been, in most cases, occasional attacks of inflam-

mation that have been very painful and severe enough to keep the patient from ordinary employments for several days.

It is true, however, that some few cases do go through life without such acute inflammatory attacks. These cases, which may be properly called exceptional, furnish no good ground for the neglect of a "weeping eye." A simple surgical operation and a few weeks of treatment will often cure the disease, and when they do not, will very much lessen the chances of the formation of an abscess. The treatment, in most cases, is chiefly local and surgical.

The little aqueduct leading along the edge of the lid to the tear-sac is slit up, and made an open canal (see adjoining figure). The passage going into the nose is dilated by means of probes. At the same time astringent washes are sometimes used upon the parts by means of a syringe, or by dropping into the eye. If there are any constitutional causes for the catarrh, these should be removed by appropriate treatment, or all local means will be of no avail.

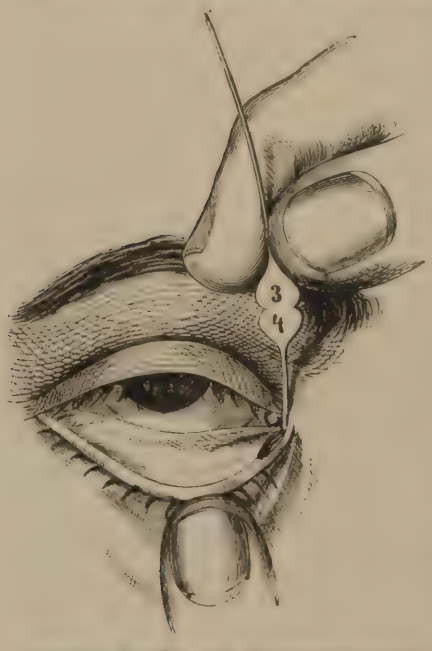


FIGURE 64.—Showing the method of probing the tear-passages. The little canal in the edge of the lid has been slit before the probing is done.

This is especially true of cases caused by syphilis. In very bad, usually neglected cases, when the bone forming a part of the walls of the canal has become diseased, it is sometimes necessary to destroy the tear-sac by caustic, or the surgeon's knife. Some cases are never thoroughly cured by any treatment in the hands of the most skilful men, but much more is done for them than was accomplished by the mode of treatment of years ago, when the disfiguring tubes were worn in the eye.

The local treatment now usually adopted, and which has been described, is that suggested by Mr. Bowman, of London. The probes used for dilating the parts are gradually increased in size until a sufficient enlargement of the narrowed canal has been attained. Nothing is left in the eye, and after the probing the patient is not required to observe any particular precautions, but goes about his ordinary employment.

If an abscess has actually formed, an incision to empty out the pus must also be made externally. The scar from such an opening is very soon obliterated. Even if an abscess has formed, besides opening this it will be necessary to open the canal into the sac, and probe the passage into the nose just as if the case were seen before the abscess had formed. The treatment is often very tedious, but, on the whole, patients seem to be well satisfied with the results obtained.

Inflammation of the Conjunctiva—Conjunctivitis.

What is popularly known as a "cold in the eye" is an affection of the mucous membrane which lines the lids and covers the front of the eye, which is called by anatomists the conjunctiva (*con* and *jungo*, to join together). This membrane is subject to various forms or degrees of inflammation, but they are all modifications of the original variety. We may classify them as: I. *Catarrhal;* II. *Purulent;* and III. *Pustular.*

There are many chronic consequences of these forms of diseases. Some of them have already been discussed in the section on the Diseases of the Lids, but they will be included in the classification for the sake of clearness:

1. Turning in of the lids (*Entropion*). 2. Turning out of the lids (*Ectropion*). 3. Thickening of the lining of the lids, granular lids (*Trachoma*). 4. Blear eyes (*Xerosis*).

Cold in the Eye—Catarrhal Conjunctivitis.

An eye that is affected with catarrh presents the following appearance: The white of the eye has a generally red color. A person who has been trained to observe, will see that all the blood-vessels are full of blood, and that there is not a ring around the cornea or window of the eye (see Fig. 65) that is redder than any other portion. There will also usually be some swelling of the lids, and the mucus and tears will flow in such quantities as to keep the eyes suffused. The patient will complain that his eyes feel as if there were sand in them, and that they became glued together at night so that they can be opened in the morning only after they are carefully washed. If the lid be turned over—rather a difficult operation for a person untrained to it—the lining membrane will be found no longer of a salmon color, with individual vessels to be seen, but it will be of a generally red, perhaps velvety appearance.

There are, however, various degrees of severity of catarrh of the membrane lining the lids and covering the front of the eye. Thus

we may have merely the sticking together of the lids with a little mucus gathered in the corner of the eye, and so little redness that only the practised observer will be able to say that there is any inflammation.

The diseases which may be mistaken for conjunctivitis are inflammations of the cornea and of the iris. Besides, we often meet with a catarrh of the conjunctiva that is merely a symptom of an overworked eye, or one that is working under improper conditions, as, for example, without glasses, when glasses should be worn. It will be seen then that it is not safe to conclude that because a patient has catarrh of the conjunctiva, he has no other or more serious trouble in addition to this.

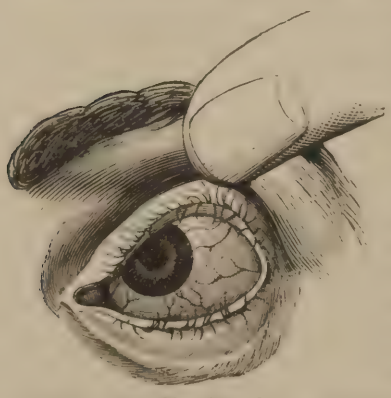


FIGURE 65.—Showing the appearance of the blood-vessels in conjunctivitis or a cold in the eye.

Causes.—It is hard to say just how a person gets a cold in the eyes. We do know, however, that exposure to a strong wind, to dust, to acrid vapors, or bright light, will sometimes be followed by a catarrh of the mucous membrane of the eyes. A severe chilling of the surface of the body may have the same effect, or excessive use of the eyes with bad or feeble light. During the course of measles and scarlet fever, especially the former, there is apt to be catarrhal inflammation of the mucous membrane of the eyes.

Treatment.—A mild case of catarrh of the eyes requires very little medical treatment, while a serious case will demand a very prompt and energetic course. The intelligent person will hardly need to be reminded that there is a tendency to self-limitation in certain diseases of the eye, as well as in those of other parts of the body.

Rest of the eyes, the avoidance of exposure to dust or bright light, perfect cleanliness of the membrane, exercise in the open air under favorable conditions, with lubrications of the edges of the lids with simple cerate or vaseline, or the like, will often be sufficient for a really mild case that is not dependent upon any faulty structure of the eyes requiring the use of glasses. The mild cases will, under this regimen, run their course, and leave the eyes as well as ever. [There is said to be a form of conjunctivitis occurring in malarious subjects, which is cured at once by the use of quinia.] After such an attack, it is well, however, to secure,

by a careful examination, an assurance that the lids have not been left at all thickened.

A severe case is one in which the lids are swelled, the eyes red and suffused with discharge, the edges of the lids very sticky, while the eyes are hot and very uncomfortable, with a sensation as if sand were in them. In such cases the eyelids should be frequently douched with cold water, or cold cloths of one thickness should be laid upon the eyes, and changed so often that they may never be hot, or even warm. When ice is convenient, the cloths, which should be of delicate muslin, or the like, may be laid upon a block of ice, and then upon the eyes. The danger in the use of poultices in such cases is very great. If advice cannot be obtained, a solution of sulphate of zinc or of powdered alum, in the strength of two grains of either to the ounce of pure water, may be dropped into the eye two or three times a day. A few drops is sufficient for this purpose. At night, vaseline, sweet oil, cold cream, or the like, should be smeared between the edges of the lids along the eyelashes. The patient should not be kept in bed, and in fine weather may walk about as usual, protecting his eyes from bright light by blue or London-smoke spectacles. Goggles should not be worn, for they keep the eye too warm.

The patient with catarrh of the conjunctiva should avoid all places badly ventilated or crowded, or those where there is smoke or dust, or a bright light or a strong wind.

As has been said, the disease is self-limited, and all the treatment is intended to guide its course rather than to cut it off.

Patent eye-washes, some of which contain substances that may be permanently injurious to the eye, such as lead, should not be used. Blisters are of no use, and simply annoy the patient. Poultices of all kinds, whether of tea-leaves, alum-curd, oysters, or bread and milk, are very dangerous to the eyes, and should never be used for any affection of any part of the eyeball. It is necessary not to do too much for a disease of the eye. When there is doubt as to what the trouble is, do nothing but keep the eyes clean, and get competent advice as soon as possible.

Purulent Conjunctivitis.

This is one of the most dangerous of the affections of the eyes. Its symptoms are, fortunately, unmistakable. The affection occurs suddenly, beginning as a catarrh. The eyelids become red and greatly swollen, so that they can scarcely be opened. Pus streams out of the eyes when the lids are pulled apart, and the pa-

tient complains of a great deal of heat and tenderness in the lids and eyes.

On separating the lids, the front of the eye is red, and sometimes it is so swollen as to be lifted up and form a ring around the cornea, or window of the eye. This inflammation may occur in the newly-born infant as well as at any time of life.

The Causes are a direct contact of the eye with pus from another part of the body of the same or another patient—for example, a careless patient suffering from gonorrhœa or leucorrhœa may bring some of the poisonous pus between his or her eyelids and thus set up an attack. Of course, matter from another eye affected with the disease will produce the disease. A surgeon may be unfortunate enough to allow some of the matter from an eye affected with purulent conjunctivitis to enter his own eye. A careless nurse may allow some of the discharges from the parts of the mother, after childbirth, to dry upon a napkin or upon her hand, and then bring it into contact with the conjunctiva of the babe, where it will dissolve and cause an outbreak of purulent conjunctivitis. It is a highly contagious disease. It should also be remembered that even a chronic catarrhal conjunctivitis may advance to be a purulent one without the direct contact of any poison from another part of the body, or from another eye. Hence we may not say that every case of purulent conjunctivitis is caused by contagion. This is rather an important point. The writer was once a witness in a case of alleged malpractice, which involved this question. It is very important to isolate the patient suffering from purulent inflammation of the eye from all persons except the attendants, until the discharge has ceased.

The utmost care should be taken that none of the implements used in cleansing the eyes of the patient should ever be used by any one else, without a thorough washing and disinfection. If one eye alone be affected, it is better to close the other with sticking-plaster and a bandage, that no pus can be carried into it.

Treatment.—If possible, a surgeon should be called in to treat so formidable a case as that now described, but if the reader of these pages is unfortunate enough to be obliged to advise in such a case, in the absence of medical aid, or be himself the victim of it, he should carry out the rules just stated about contagion, and then proceed to apply ice-water or very cold water, night and day, and to cleanse the eyes with tepid water at least once an hour. At the same time the eyes should be washed with a solution of alum, in the proportion of a teaspoonful to a pint of water, six or seven times a day. This treatment is applicable to the child just born as well as to the adult. In the former case a little more care is to be

taken in regard to the use of ice, lest the tender lids become excoriated. In case the very cold water causes great discomfort it should not be used.

Cleanliness of the eyes is the most important part of the treatment. Small bits of old linen, very soft and very fine, of a single thickness, dipped in tepid water, are the best means of cleansing the eye. The use of a syringe in unpractised hands is somewhat dangerous both to the patient and to the attendant. The surgeon may use, in addition, leeches and nitrate of silver, if his judgment dictates, but the non-professional attendant should not venture on any more positive treatment than that which has been delineated.

Opening the lids in order to clean the eyes will require some tact and patience. The attendant, however, should not be satisfied unless he does actually open them by gently pulling them apart, after soaking the edges so that the matter may be wiped out, or a stream of water be allowed to pass between them. The same rule as to poultices, or any kind of continued warm applications to the eyes, is to be observed here as in the treatment of catarrh.

Poultices break down the delicate tissue of the front of the eye, and if applied even for a few hours, may ruin the sight. The most deplorable consequences of this kind of treatment are constantly to be seen in dispensaries and infirmaries, and sometimes in private practice. But these remarks are not to be construed as an objection to using warm water for a few moments at a time.

Consequences of Acute Conjunctivitis.

Both catarrhal and purulent conjunctivitis, even if they are subdued without damage to the front of the eyes, sometimes leave behind consequences that are dangerous to the integrity of the organ, such as chronic inflammations and distortions of the lids. Chronic conjunctivitis should be treated by mild astringents, such as alum, two grains to the ounce, and by lubrication of the edges of the lids with vaseline, cold cream, mutton tallow, etc. Great care should be taken to avoid exposure of the eyes to improper influences. But the advice of a medical man can usually be had in chronic cases of this kind. This is the more necessary, because a case of supposed chronic inflammation of the mucous membrane of the eye sometimes turns out to be an inflammation of the deeper parts, which is a more serious matter, and requires very different treatment.

The patient who believes that his affection is one of the conjunctiva merely, should make himself sure of that fact when the opportunity offers. Besides, a chronic affection of the mucous

membrane may, by direct extension, become one of the deeper parts. The boundary lines of disease are not always distinctly marked.

Thickening of the Lining of the Lids—Granular Lids—Trachoma.

The so-called granular lids are by far the most frequent consequences of neglected inflammation of the mucous membrane (conjunctiva) of the eye. Lids are, however, often supposed by non-medical persons to be granular, when they are not at all so. The red line along the edge of the lid, which shows that there is disease of the roots of the lashes, or of the glands, is sometimes supposed to be one of the symptoms of a granular eyelid. Unless the lids are turned over so as to expose the membrane lining them (see anatomy of eyelids), it is impossible to say, whether or not, they are granular. It requires some little knack and experience to turn over the upper eyelid, hence the changes there, or the presence of foreign bodies upon it may escape notice. The little operation of turning over the upper lid is performed in the following manner: The patient should sit down with his head supported by another person, or leaning against some good support, while the operator stands in front. The person whose lid is to be turned over, should then look down. This is not always an easy thing to do, for the natural inclination when told to look down, is to turn the whole head downward, and not the eyes. It is the latter that is wanted, for when this is done, for evident reasons, it will be much easier to turn over the lid. After the patient has turned the eye well downward—and this action may be facilitated by telling him or her to look at his hand, or the like—the operator seizes hold of the very edge of the lid by the fingers of the right hand, and stretches it downward, and at the same time presses the skin of the eyebrow with some firmness upon the bone. The second stage of the procedure consists in turning the lid over the thumb. No pencil, penhandle, nor instruments but the two hands are needed for this little operation. The person who learns to perform it will sometimes be the means of relieving from much suffering, perhaps, a fellow-passenger in a railway carriage, who has got a cinder under the eyelid. As has been said, it is only when the lids are well turned over, that we can say that there are granulations, or, to speak more correctly, thickening of the lining membrane of the lid.

When once the lids are turned over, if there are granulations, instead of seeing the salmon color of the membrane, we find it of a

deep red hue ; instead of perceiving the individual blood-vessels like little threads, we find a general velvety appearance, and perhaps we see very minute bodies, looking like the spawn of fish or frogs.

As has been said, granular eyelids are the result of an inflammation of the lining membrane. This being unchecked causes the tissue to grow, that is, its natural structures become enlarged. The disease is very apt to be associated with a low state of the general health and bad habits of life, although a patient may be in full health and yet suffer from the disease. If unchecked, thickening of the conjunctiva causes deplorable consequences. The cornea or window of the eye is finally covered over with blood-vessels, or ulcerated, or becomes opaque, and thus the sight is very much impaired, and sometimes nearly destroyed. When things have gone on to this state, a cure is often impossible.

Treatment.—While all attention should be paid to any defect in the mode of life, or food, or habits of the patient, the treatment is pre-eminently local. What are known as astringents, and astringent caustics—such as alum, sulphate of copper, tannic acid—are applied to the eye by a surgeon, while the patient protects his eyes from bright light, keeps them very clean by frequent bathing in tepid water, and uses a mild wash of alum, or sulphate of zinc (two grains to the ounce) or the like, and anoints the edges of the lids with ointments such as have already been mentioned. Patients with thickening of the lining of the lids should remember that this is a chronic disease, and not self-limited, like many an acute one. The golden plan for treating granular lids is that of prevention. A cure must often be, at the best, only partial ; besides, in many cases, the treatment will require months and even years.

Growths upon the Mucous Membrane of the Eye—Pterygium.

This is an affection which may, perhaps, arise independently of any general inflammation of the conjunctiva, or which may be a consequence of it. It is a triangular-shaped thickening of the membrane and enlargement of the blood-vessels situated in one or both corners of the eye. The apex of this triangle is toward the cornea. From its fancied resemblance to the wing of a bat, it has the name, in surgical science, of *pterygium* (little wing). It is probably caused by inflammation, and occurs chiefly in those whose eyes are constantly exposed to a long sweep of winds on prairies, on the seas, etc. It is not necessary to interfere with pterygium

unless it grows upon the cornea, when it may be removed by a surgical operation. The scar from the removal of a pterygium

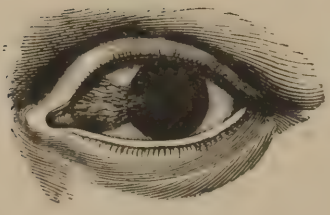


FIG. 66.—Pterygium.

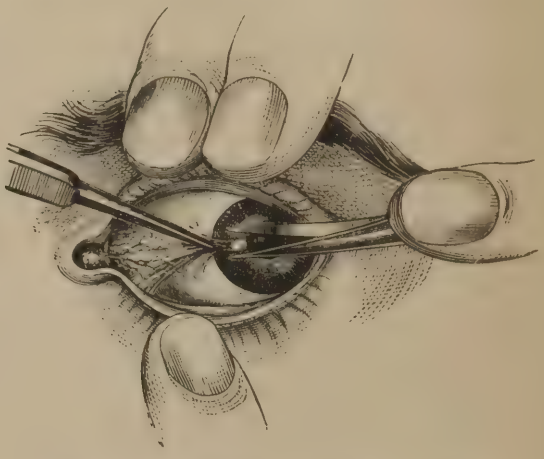


FIG. 67.—The operation for removal of pterygium.

disfigures as much as the disease itself. Astringents and the like are of no service in cases of this kind.

There are other very small, almost infinitesimal tumors sometimes found upon the conjunctiva, not usually large enough to constitute a blemish. They may be cut off if they cause deformity.

Adhesion of Lids to the Ball—Symblepharon.

The eyelids sometimes grow to the ball of the eye, in consequence of burns which have destroyed the mucous membrane. It is extremely difficult to break up these adhesions permanently, and the most skilful operations do not always succeed. (See Burns of the Eye.)

Foreign Bodies on the Outside of the Eye.

Any substance which has no proper place in or upon any part of the body is called, in technical language, a "foreign body." The lodgment of foreign bodies upon the outside of the eye is of very frequent occurrence. Railway and steamboat travel are fertile sources of such intruders as cinders, while those who work in machine shops are in constant danger from sparks and bits of metal entering the eye. In the firing or accidental explosion of firearms there is another source of danger from percussion caps or grains

of powder. Children climbing up and down trees have been known to get buds and bits of leaves on the outside of the eye.

It is a cardinal principle in examining an eye to first look for a foreign body, especially when symptoms of inflammation are present. This can only be done thoroughly when the lids are turned over by the method already described on page 268. Any small blunt instrument, or even a handkerchief, is sufficient to remove an offender from the lid, but to remove one from the cornea, or transparent front of the eye, sometimes requires very delicate instruments and much skill. Workmen in machine shops often acquire much of this dexterity. The danger in working at foreign bodies on the transparent part of the eye, is, that they may pass through this thin and delicate membrane, or that rude attempts to remove them may push them further in. A foreign body *on* the eye is a very painful and troublesome affair, and may be serious ; but a foreign body *in* the eye is *always* extremely dangerous, not only to the eye in which it is, but also to the fellow eye, so that the utmost care should be taken by the inexperienced person when called upon, as he may sometimes be, to remove a foreign body from the front of the eye. If necessity compels the interference of a non-medical person, he should first place his patient in a position where the eye is in a very good light, and where the sufferer can lean his head firmly against some support. Then, having the assistance of one other person, if possible, he should endeavor to tilt, with a delicate bit of wood or the like, the substance from off the front of the eye, while he holds the lids firmly but gently apart. Only a blunt instrument should be used on the eye by any but a surgeon.

There is a popular notion that "eye-stones" * [or flax-seeds] are valuable means of removing foreign bodies from the eye. The writer knows travellers who carry them constantly, and who not only use them on their own eyes, but confidently advise them to others. They often accomplish the removal of the foreign body, but sometimes they do not ; then they cause serious inflammation. They act by producing an irritation of the lids, which causes a great flow of tears that may wash out the offending body. Besides, they hold the lid a little off from the ball, and thus give more room for the escape of the foreign substance. If there is no person near the suffering one who is able to turn over the lid, eye-stones should not be used, but the following plan may be tried, which will usually be successful, unless the foreign body is upon the cornea : The lid should be put on the stretch and held away

* An eye-stone is a hard and smooth substance found in certain shell-fish.

from the ball, and at the same time should be stroked directly downward. Rubbing in various directions is to be avoided, for thus the foreign body may be rubbed deeper into the tissue. An eye-stone has no mysterious virtue, and is simply another foreign body introduced into the eye.

Inflammation of the Cornea—Keratitis.

About one-half of the whole number of cases of disease of the eye involve the cornea. They are very important cases, because impairment of the transparency of this beautiful and essential membrane, or even a change in its curvature, renders distinct vision an impossibility.

"Those that look out of the windows are darkened," for the cornea is the medium through which the light enters to undergo the changes that transform it into vision. Diseases of the cornea are of two general kinds : *primary* and *secondary*.

The primary are perhaps more dangerous. The secondary form, consequent upon neglected granular lids, have been already alluded to. I shall attempt to describe but a few of the forms in which inflammation of the cornea may occur. The general divisions, however, of these dangerous diseases may be thus given : I. Ulcers and abscesses of the cornea. II. General opacities. III. Blood-vessels upon the cornea.

Ulcers of the Cornea.

Ulcers and abscesses of the cornea usually occur in persons who are not strong and well, so that a recent white spot, which is not a foreign body, is an evidence of some failure in the general health. These spots, which the experienced eye may recognize as actual losses of substance or little pits in this membrane, are usually caused by the change of the proper elements into pus.

Inasmuch as this tissue is not supplied with blood-vessels, it is peculiarly liable to disease, but on the other hand this want is somewhat made up by the abundance of nerves, which often give timely warning of danger.

Treatment.—All diseases of the cornea that are not caused by foreign bodies, or that are not dependent upon granular lids, or other mechanical causes, demand, first of all, attention to the general health of the person affected, which usually has been impaired by improper habits of life, constitutional disease, or the like. Besides this, the eye should be protected from a strong or dazzling light, from dust, wind, tobacco smoke, etc. Protective

spectacles of a blue or London-smoke tint, and shades are generally necessary.

Eyes affected with inflammation of the cornea should not be used for reading, writing, sewing, nor indeed in any employment on objects near at hand.

Confinement of the patient for any great length of time to a dark room is not usually proper in any kind of disease of the eye. The most exaggerated notions as to the necessity for the exclusion of light in such affections are very commonly held. In the case of disease of the cornea, the irksomeness of life in a dark room, and the absence of fresh air will have an injurious effect upon the general health of the patient. Bandages, spectacles, and shades, furnish sufficient protection in nearly all cases. These allow the patient to go about in the open air and sunlight. Eyes that have been operated upon, and in which it is necessary to secure union of the cut surfaces by perfect rest, with a few others, are the only cases that demand confinement to one room for considerable time.

Oculists use various drugs in the treatment of ulcers of the cornea, and they sometimes resort to surgical operations. Sulphate of atropia, a preparation of the plant known as *Atropa Belladonna*, is the one most frequently used. The effect of belladonna upon the eye is to enlarge the pupil, and it is thought that it contracts the blood-vessels, and relaxes the muscles of the eye.

Nitrate of silver, leeching, and blisters, are not applicable to ulcers of the cornea. Atropia often quiets a very painful eye in a short time, but it should not be used, except under medical advice, unless absolutely necessary. The strength of the solution ordinarily used, is two grains to the ounce of distilled water, and one drop is sufficient at each application.

Spots upon the Cornea.

Diseases of a milder type than ulcers, and ulcers that have run their course, often leave spots upon the cornea. They are usually permanent, although, in the case of young persons, they may sometimes be obliterated in the course of time. In recent cases surgeons sprinkle irritating powders and place ointments upon the eye, which sometimes assist in the absorption of the opacities. These dense white spots on the cornea are sometimes improperly called cataract by non-medical persons. It is often supposed that they may be removed by an operation, but this is incorrect. They should not be interfered with in such a way.

Inflammations of the Cornea.

There are several distinct forms of inflammation of the cornea which it is impracticable to describe minutely, as would be done in a treatise for students of medicine, but there is one form that is so common and so dangerous that an attempt will be made to give a sketch of its symptoms.

Pustular Inflammation of the Cornea—Phlyctenular Keratitis—Scrofulous Keratitis.

Physicians often find very minute bladders upon the cornea in young children who are improperly or insufficiently fed. These little bladders (vesicles) are usually soon covered by blood-vessels, or become ulcers by breaking down and extension, and they are generally accompanied by swelling of the lids and great fear of the light, so that the eyes are kept tightly closed, and when they are forcibly opened hot tears run out. The face is very often disfigured by fissures and ulcers upon it, the lymphatic glands of the neck swell, the tongue is at the same time furred, and the patient, who is usually a child or young person, has a very sorry and distressed appearance. To the inexperienced person this disease resembles purulent inflammation of the mucous membrane of the eye, but careful observation will show that it is not *matter* or pus, but *water*—tears, that flow out from between the lids when they are forcibly opened. This is the great distinction between the purulent inflammation of the mucous membrane of the eye, and a severe case of inflammation of the cornea, of the kind just described. Mild cases, when there is very little swelling of the lids, will, of course, not cause any such mistake to be made.

This form of inflammation very often *begins* in the conjunctiva. A long-continued inflammation of this kind upon the conjunctiva will invade the cornea also.

Treatment.—That which has been said upon page 272, sufficiently covers the ground as to corneal affections in general. It is only necessary to add that no applications that cause pain or even severe smarting, should be made to an eye suffering from disease of the cornea, unless under the advice of medical authority.

Inflammation of the Cornea from Inherited Syphilis.

There is an inflammation of the cornea occurring in young persons and in children, which is the result of an inherited constitu-

tional disease—syphilis. In other words, when one or both parents are syphilitic, their children may be born with, or soon exhibit, disease of the cornea. The cloudiness of the cornea, is, in these cases, usually accompanied by catarrh of the nostrils and throat, impairment of hearing, and a peculiar want of development of the central upper teeth which causes notches to form in them. Local treatment is of very little service in these cases, but the appropriate constitutional and hygienic treatment will often entirely cure the affection.

Results of Inflammation of the Cornea.

One of the results of a severe inflammation of the cornea, so severe that it bursts and allows the pupil to fall forward upon it, is a change in its shape, so that the whole globe is deformed. There is a great variety of these disfigurements. The globe is sometimes so much enlarged that it cannot be covered by the lids. Again, some portions of it protrude, while the other parts of the ball retain their proper shape. When the iris or the choroid coat of the eye falls forward in this manner, their black or dark color,

FIGURE 68.—Partial staphyloma of the cornea.

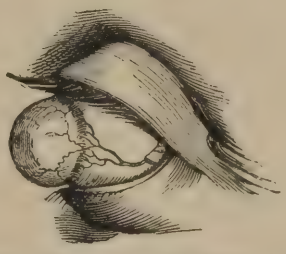


FIGURE 69.—Total staphyloma of cornea. Such an eye may readily become an irritant to its fellow.

through the thinned white of the eye, cause an appearance not unlike that of a brown grape ; hence the medical name for these protrusions of the eyeball is a "grape-like tumor"—*staphyloma*. They greatly disfigure the patient, and when the eye is sightless, as many of such eyes become, it may be removed by a surgical operation, after the individual has attained full growth, and an artificial eye may be worn. Sometimes a deformed and protruding eye causes a sympathetic affection of the other eye. In such a case its removal is imperatively required, and no delay should be allowed. The subject of *sympathetic inflammation* of the eye is fully discussed on another page.

Conical Cornea.

This is quite a rare affection of the cornea that impairs the sight very much, but which easily escapes the attention of the unpractised observer. In this disease the cornea remains transparent, but its curvature is altered, so that instead of being a certain part of a sphere, it assumes the shape of a cone. The affection generally occurs in weakly persons, although those who are apparently healthy and strong may suffer from it.

Conical cornea causes very great impairment of vision if it exists to any extent. The eye is short-sighted from being lengthened from before backward, and from its irregular curvature there is great distortion of the images formed on the retina.

The Treatment of this affection is not, on the whole, satisfactory, although, at times, something may be done by a surgical operation which aims to flatten the cone. Spectacles containing only a transparent slit are sometimes of service.

Diseases of the Sclerotica, or White of the Eye.

The diseases of the white of the eye, or of the sclerotica (*hard* tunic) are not of sufficient importance to lead the writer to do more than name them in an article of this kind. This part of the eyeball participates in the inflammations of the cornea, and of the lids and iris, as well as the interior parts of the eye, and shows this by an undue redness, which the careful observer may distinguish from that of the mucous membrane covering it. It may also become so thin in the course of disease as to allow the brown coloring matter of the choroid coat to show through. There are persons, however, who are born with a thin sclerotica or white of the eye, so that the reader may not be alarmed if he detect a faint tinge of brown glimmering through the white of the eye.

The sclerotica may also protrude in various parts and deform the eyeball. A *wound* of the sclerotica is dangerous to the eye.

Inflammation of the Iris—Iritis.

This is a dangerous disease, and is sometimes mistaken for one that is not so important—that is, catarrhal inflammation of the outer membrane of the eye, or, as it is popularly called, *a cold in the eye*, described on page 263. Probably no pictures or descriptions will give a clear idea of this affection, but I will attempt to state some of its prominent symptoms, so that those upon the sea

or in remote places who read this section, may be somewhat on their guard if called upon to advise in regard to, or if they suffer from, an inflammation of the eye.

1. The first prominent symptom is *severe pain in the eyeball* and about it. This is a symptom found also in some inflammations of the cornea, in inflammations of the back part of the eye, so that it is not a distinguishing sign of this disease. An inflammation or disease of the cornea will soon be detected by any intelligent person who studies the symptoms on page 272 to 274.

A cold in the eye does not, as a rule, cause pain severe enough to keep a person awake at night. The sensations from a catarrh in the eye are rather those of discomfort. With any considerable catarrh there is some gluing of the edges of the lids on awakening from sleep. This does not usually occur in iritis. The pain from iritis is severe, and it is apt to extend in the course of the nerves to the forehead, the side of the head, the cheeks, and even to the teeth, so that it may be mistaken for neuralgia of the face. Neuralgia affecting the eyeball is always a serious symptom. It may mean an inflammation of the iris, or that other still more dangerous affection, hardening of the globe of the eye—glaucoma.

2. *Dread of light* and involuntary closure of the eyelids. This symptom, as has been shown, is also seen in keratitis, especially in that of young children.

3. *Contraction of the pupil.* Wherever an eye is very much reddened, and medical advice cannot be obtained, the pupil of the eye should be carefully examined under a good light. The natural or healthy pupil will open and shut, so to speak; at least it will contract and dilate under strong light. This test may be made by alternately opening and closing the lids in strong light. The lids should be closed and then opened very rapidly, and the pupil carefully watched the instant the eye is opened. If the pupil does not move, and if there be pain and fear of light, we may strongly suspect the existence of an inflammation of the iris.

4. The *character of the redness* of the eye is also of great importance. Only a close observer will get much from this symptom, however. Such an one will find that the redness in iritis is confined chiefly to the ring made by the cornea, as it fits like a watch-glass into its case, and that it radiates from this surface—that it is not a net-work-like redness such as we see in a cold in the eyes.

If one is obliged to form an opinion in a given case as to whether it be an affection of the iris or not, a drop of a solution of the sulphate of atropia, of the strength of two grains to the ounce, or even much weaker, will soon settle the question. If

the pupil dilates freely and promptly, and becomes large and circular in a few minutes, our fear of iritis may be gone. As has been indicated, the determination that a case of inflammation of the eye is not one of the iris, is a very important matter, for if an iritis be not properly treated, the eye will very soon be lost. For this reason, if the reader is obliged to make a decision as to whether or not a case is one attacking only the outer membrane of the eye, he should proceed with great care, and if, finally, he is not able to decide positively, he should adopt the treatment for iritis.

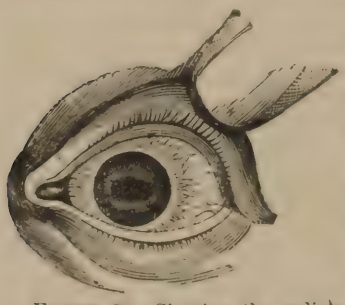


FIGURE 70.—Showing the radiate character of the overloaded blood-vessels in iritis, and also the irregular pupil.

Causes.—The causes of iritis are quite numerous, but one of two constitutional diseases are very apt to be at the basis of an inflammation of this kind. These are syphilis and rheumatism. Extensive use of the eyes may perhaps produce the disease without the existence of any rheumatism or syphilis, but by far the larger proportion of cases occur in connection with these diseases. In the inflammations of the eye occurring after accidental injuries and surgical operations, the iris is generally involved. The so-called sympathetic inflammation is largely one of the iris.

Treatment.—From what has just been said, the treatment for iritis will naturally be both *constitutional* and *local*. Here, however, the local treatment is pre-eminently important, for if neglected, serious mechanical impediments to perfect vision may occur. The most important local application in a case of iritis is some one of the preparations of belladonna. The best of these is the sulphate of atropia. It should be used of the strength of two grains to the ounce of water, a drop being placed in each eye from three to six or more times a day, according to the severity of the symptoms. A camel's-hair brush, a bit of cotton-wool twisted on a match or wire, or a dropper, such as is readily obtained in the shops, are some of the convenient means of getting the solution in the eye. The fluid extract of belladonna, using a solution of from one to six drachms to the ounce, or the belladonna ointment, may be used in case of necessity as substitutes for the more elegant, efficacious, and convenient sulphate of atropia. The ointment should be rubbed about the forehead, while the belladonna lotion may be used as an eye-wash. The object of these local remedies, upon whose use so much stress has been laid, is the dilatation of the sluggish pupil. If the pupil be not kept widely

dilated, it will fall upon the lens of the eye, and become glued to it. This will cause two serious consequences.

1. The lens will become opaque from the adherence of the coloring matter (the so-called pigment of the iris) to its transparent surface.

2. The opening and shutting of the pupil which forms so important a part of the mechanism of the eye, and which is an affair of momently occurrence, is so much interfered with by the adhesion of various parts of the circle, that the eye is always in a state of irritation, which is analogous to the irregular action of clogged machinery. For these two reasons, and for others which need not be mentioned, many an eye that has undergone inflammation of the iris, is destroyed long after the pain, redness and dread of light have disappeared.

Excessive and Constant Enlargement of the Pupil—Mydriasis.

When the pupil is constantly enlarged, so that it does not dilate and contract, it may be a symptom of various diseases. The chief cause, however, is a paralysis of the branch of the third nerve, which starts from the brain, and which has much to do with the motions of the eye. (See Anatomy of the Eye.) It sends off one branch to the muscle which contracts the pupil. Of course, a disease sufficient to destroy its power, will render the muscle unable to do its work. Dilatation of the pupil often occurs in connection with paralysis of the branch of the third cranial nerve supplying the upper lid, so that the lid drops down and cannot be lifted (*ptosis*). Affections of these nerves are often caused by syphilis, but the breaking of a blood-vessel, and a pressure upon the course or origin of the nerve, is also a not uncommon cause of this kind of paralysis. Certain drugs, such as hyoscyamus, belladonna, and stramonium, have a remarkable power in causing dilatation of the pupil. They are used by physicians as applications to the eye, especially the different preparations of belladonna. Persons wishing to simulate disease sometimes use these drugs for the purpose of deception.

Contraction of the Pupil—Myosis.

This is also a symptom of paralysis of the nerve supplying the muscle that dilates the pupil, and also of certain diseases of the spinal cord. It may also be produced by the local or constant use of Calabar bean, or of opium. It is one of the marked symptoms of poisoning by the latter.

Congenital Defects of the Iris.

There are certain congenital defects of the iris which require mentioning. The iris is sometimes entirely absent. It is sometimes cleft or deficient in one part. The pupil may also be out of place, and there may be more than one pupil. These are rare defects, and they are without remedy. Not very unfrequently one iris is of a different color from the other. Where the difference is very marked, the contrast is almost a disfigurement. This difference depends upon the amount of coloring matter in the iris, and is of course not amenable to any treatment.

Cataract.

Any want of the natural transparency of the lens is called cataract, from the old idea that a veil fell down before the eye. As has been seen on a preceding page, in the Anatomy of the Eye, the lens in health is a transparent body, but disease changes this so that it becomes completely or partly opaque.

Cataract may be conveniently divided into four great classes :

1. Cataract of youth ; 2. Cataract of old age ; 3. Cataract from injury; 4. Cataract from inflammation.

Some children are born into the world with opaque lenses. The cause is probably some want of nourishment of the lens when the child is in the womb. The lens, as has been seen, depends for its support upon the surrounding parts of the eye, for it has no blood or lymph vessels of its own. Any interference with the health of the blood-vessels of the eyeball may affect the lens. When a child becomes a few months old, and does not steadily fix its eyes upon any one point when looking, we may suspect that there is either an opacity of the lens or, still worse, a disease of the retina or optic nerve. Infants of two or three months of age, however, do not fix their eyes upon any object, but roll them about with no steady gaze. A marked opacity of the lens may be detected by any good observer, for, on looking beyond the black of the pupil, the grayish-white opacity may be seen ; where, however, the opacity is not complete, the use of a lens or of the ophthalmoscope is necessary to distinguish it.

Treatment.—The only remedy for cataract is a surgical operation. No internal or external medication has as yet been discovered, which will cause an opacity of the lens to disappear. In a few very rare cases a cataract may disappear spontaneously. When a child is strong and healthy, and it is known by tests that

it can perceive light through the cataract, and hence that the retina and optic nerve are sound, it is proper to operate for the removal of the cataract. The operation usually performed in the case of young children is by means of a delicate needle, which is plunged into the capsule or envelope of the lens, so as to wound the lens-substance itself. This being done, the lens-substance escapes into the aqueous humor of the eye, swells up somewhat, but the most of it is finally absorbed, leaving the lens very much smaller, or perhaps entirely removing it. The operation is then repeated one or more times if necessary, at intervals of time that vary according to the amount of inflammation that has been set up by the operation, until finally enough of the lens has been removed to allow the rays of light to pass without interruption through the pupil.

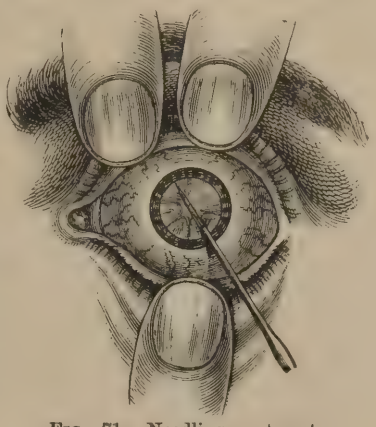


FIG. 71.—Needling a cataract.

The operation is not entirely without danger, for in some rare cases the inflammation following it is so severe as to cause the loss of the eye. As a rule, however, it gives sight.

2. *The cataract of advanced life* occurs usually after 55 years of age. Prematurely old and decayed people may be affected at an earlier period.

Inasmuch as the symptoms of cataract are similar to those from loss of sight from widely different causes, it is not worth while to enumerate them here, except that we may give a few general hints that will enable the reader to suspect the existence of cataract in given cases. True senile cataract is a painless affection. Loss of sight occurring during attacks of pain, notably neuralgia, should always excite alarm, and secure, if possible, surgical advice. Persons affected with cataract are apt, in its early stages, to see better in the twilight than in a very great illumination; whereas, in diseases of the optic nerve or retina, the greater the illumination the better the vision. Until the cataract is fully developed, when it can be seen as a whitish opacity in the pupil, only one positive proof of its existence can be furnished, and that is by the use of the ophthalmoscope—the mirror for observing the back of the eye. If a disease be cataract pure and simple, and there be no serious affection of the back of the eye, the light of a candle will always be perceived through the lens, even if it be very opaque. The

lighted candle should be seen throughout all the parts of the visual field, even if the patient be looking straight in front of him, while the light is being moved about. An eye that is sound except as to the opacity of the lens, should always be able to tell where the light is, even when the eye is looking directly forward. No eye is fit for the operation of removal of cataract that does not thus perceive the light through the opaque lens. There are diseases of the back part of the eye that finally cause opacity of the lens. Sometimes the friends of patients have mistakenly allowed such diseases to go on without an effort to check them, waiting for the cataract to become fully formed. When cataract occurs in this class of cases, it is too late to do anything to effect a cure, because the opacity of the lens is sometimes the last stage or an inflammation leading to blindness.

Treatment.—A true senile cataract may be removed by an operation which takes the lens entirely out of the eye. Formerly the lens was sometimes pushed away from the pupil by means of

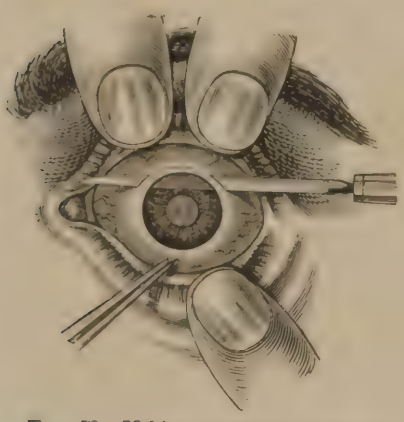


FIG. 72.—Making an opening in the cornea for the removal of cataract.

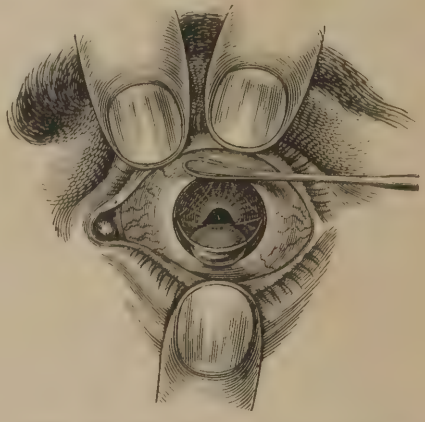


FIG. 73.—Extracting the lens in a cataract operation.

a needle passed into the eye. This operation has been abandoned by the medical profession, because the lens thus displaced sooner or later acted as a foreign body, and caused an inflammation of the eyeball which destroyed the sight. The operation of extraction was brought into general use by Beer, an Austrian surgeon. It has undergone many modifications since then, notably those suggested by the late Professor Von Graefe, of Berlin. About eighty per cent. of those operated upon by good surgeons recover useful, and some of them excellent sight.

Cataract sometimes occurs in diabetes. The results of its re-

moval in such cases are not so good as those from the removal of ordinary senile cataract.

Diseases of the Retina, the Choroid, and the Optic Nerve.

Inasmuch as none of the above-named diseases can be known positively to exist, except after the eye has been examined by the ophthalmoscope, it will not be possible to give more than an indication of their nature. Many of them were formerly grouped together under the heading of *amaurosis*, but since the ophthalmoscope has been invented—which enables the physician to detect and describe such changes in the retina as the escape of blood from its vessels, changes in its color and structure, whitening and

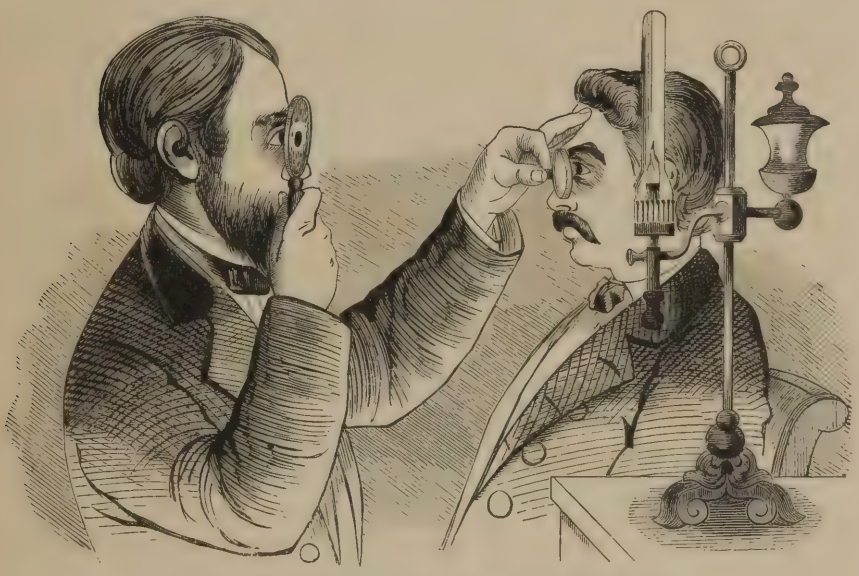


FIG. 74.—One of the methods of using the ophthalmoscope.

swelling of the optic nerve, rupture of the choroid coat—no such rude classification as amaurosis is adapted to these days of better knowledge. Before giving a list of the affections that may attack the back part of the eye, we may give a brief account of the invention and nature of the instrument used by physicians for examining the retina, choroid, and optic nerve.

A practicable instrument was first invented by Heinrich Helmholtz, then professor in the University of Königsberg, in Prussia, now, however, professor in Berlin. The scientific men of the world, from Aristotle down, had vainly endeavored to give a reason for the

blackness of the pupil. It was known that the lens was transparent, as also the vitreous humor (see Anatomy of the Eye), and that the choroid coat had very many blood-vessels. Why, then, was not some of the red color reflected so that it could be seen through the pupil? By accident—if there are any accidents—in one of the rooms of the Berlin University, it was discovered that if light could be made to enter the eye in a certain way, its reflection would be red, and the pupil would be no longer black. From this standpoint Professor Helmholtz proceeded, and he soon invented a mirror by which light can be thrown into the eye and caused to emerge in such a direction that the retina, choroid and optic nerve can be seen by the person holding the mirror. The eye-mirror enables the observer's eye to be in the path of the reflected rays without cutting them off, or intercepting them, as the head of the observer does, when, without the aid of artificial light and a mirror, he looks straight forward into the pupils of a person in front of him.

Scores of modifications of Helmholtz's original instrument have been made, and it is seldom or never used exactly as first invented. Yet, in spite of this, Helmholtz left no principle to be discovered when he presented his first instrument to the world, and he must always be considered as the first man who enabled us to see the optic nerve, the choroid and retina in the eye of a living subject.

Diseases of the Retina.

1. The retina may become inflamed and opaque as a result of over-use, or improper use by bad light, and as a consequence of syphilis, diabetes, and other diseases.

2. Its blood-vessels may break in consequence of a change in their walls, the result of old age, or from poisonous materials in the blood—such as are retained in the course of certain diseases of the kidney.

3. The retina may be separated from the other parts of the eye. This accident, which is a very serious one, occurs chiefly in near-sighted people. (See Short-sightedness or *Myopia.*)

4. The retina may be the seat of cancerous tumors. These chiefly occur in young children, and are sometimes not detected until the tumors have grown to such a size as to present themselves in the pupil as a whitish reflection, which may possibly, by an untrained observer, be mistaken for cataract. Removal of the whole eye before the disease has passed through the ball, is the only remedy in this desperate disease.

5. The retina may be congenitally diseased, perhaps as a result

of inflammation or arrested development before birth ; for a child in the womb is subject to disease as well as one that is born.

Such patients need a much better light than those who have a sound retina, and are, consequently, not able to get around well in the twilight or evening. Such cases are often included under the term "night-blindness."

Night-blindness is an incurable affection, yet sufferers from it do not usually become entirely blind, although they may not be able to see small objects.

Diseases of the Choroid.

The choroid coat of the eye may also be the seat of diseases similar to those affecting the retina, and from similar causes. Since it is the continuation of the iris and the ciliary body (see Anatomy of the Eyes), it participates in most of the affections of the pupil or iris.

Diseases of the Optic Nerve.

1. The optic nerve may become inflamed ; it may suffer from the breaking of its blood-vessels, and it may shrivel or atrophy.

The Causes of these various affections are the same as those that have been enumerated under the inflammations of the retina.

2. Pressure upon the optic nerve at its origin in the brain, or in its course to the eyeball. This pressure may be caused by the breaking of a blood-vessel, by a tumor, or by inflammation of the brain.

Any considerable disease of the optic nerve must cause loss of sight, for it is by its action that the impressions of waves of light are in some unknown way carried to the brain, there to produce vision.

Diseases of the Optic Nerve and Retina from the Abuse of Alcohol, Tobacco, and so forth.

It is well known that many persons who are intemperate in the use of alcohol and tobacco suffer from what are called "weak eyes." Their eyes are red and watery. This condition is simply a form of conjunctivitis, and is not a serious matter, since a change in habit is sufficient to readily cure what is not, at the worst, any more than an inconvenience. There is, however, a form of disease of the back part of the eye from the excessive use of stimulants and narcotics so serious as to require especial men-

tion. Fortunately for the race, only a small proportion of those who are intemperate in drinking and smoking lose their sight on account of this vice.

The most prominent symptom of what is sometimes called *Tobacco Amaurosis* is a gradual loss of sight. Whenever the sight begins to fail in a person who uses tobacco in excess, especially if, at the same time, he uses strong drink freely, we may suspect the cause. The examination of the eye in these cases sometimes fails to detect any marked appearance of disease, either on the inside or outside. If the tobacco and alcohol be not given up entirely by such patients, blindness will result. Indeed, almost the only treatment necessary for loss of sight from excess in tobacco and alcohol is the total abstinence from these agents.

Very large doses of quinine sometimes, in very rare cases, produce blindness. This is usually temporary, however.

The blindness in yellow fever is one of the rare symptoms of the poisoning of the blood, or pressure upon the circulation in that disease.

Diseases of the Vitreous Humor.

Affections of the vitreous humor (see Anatomy of the Eye), are usually secondary to those of the choroid coat and retina, and are made known to the patient by the presence of motes, particles, or the like, apparently floating in front of the eye. The ophthalmoscope enables the surgeon to see these particles clearly. Sometimes they are composed of blood, of coloring matter, or of the broken-up parts making up the normal vitreous humor.

There is another kind of floating particles seen by the patient which need cause no great alarm, for they are often observed when, so to speak, they have no real existence. All these appearances of floating bodies in the eye are grouped together under the head of muscæ volitantes (*musca*, a fly, *volitare*, to fly about).

The innocent form does not cause any defect in vision, that is to say, the patient is able to see letters or objects just as well as ever. The chief annoyance is experienced in perceiving bright beads or strings floating about when the subject of them looks at a bright and clear surface. They are actually the cells of the vitreous humor, which, in some eyes not necessarily unhealthy, are seen in this manner. The appearance of floating bodies in the eye, when connected with loss of vision, or limitation of the space in which distinct vision is enjoyed, is always a serious symptom; but without these changes it need excite no apprehension.

Animal parasites have been found in the eye. Their origin is

due to eating raw meat in which the germs of these parasites existed—just as trichina and tape-worm are due to eating measly pork. An expert alone could determine the existence of such parasites in the eye, unless they are in the front—the anterior chamber. Fortunately, they are exceedingly rare. They may also exist in the eyes of animals.

Undue Hardness of the Eyeball—Glaucoma.

Glaucoma is an affection of the eye that cannot, as yet, be classified under any of the heads that have been enumerated in the account of its various diseases. Its nature is not thoroughly understood, although we have ample means for its recognition as a disease, separate and distinct from any other affection of the eye.

Since the sight may be irrecoverably lost in a few days, unless it be recognized when in an acute form, I shall attempt to impress a description of its prominent symptoms clearly upon my readers. Although I fear that I shall not succeed in causing the unprofessional reader to be able to know a case of acute glaucoma when he actually sees it, at least, I hope to be able to cause him to suspect it.

I. Glaucoma usually occurs in persons past middle life.

II. It does not often occur in short-sighted eyes.

III. Its chief symptoms are: *a.* Neuralgic pain in and about the eye; *b.* hardness of the globe of the eye; *c.* rapid loss of the power of adjusting the eye for vision, so that glasses must be changed very often in order to get those strong enough to do the required work; *d.* there are sometimes sudden and temporary attacks of blindness; *e.* the pupil of the eye is usually larger than is natural.

The name of Glaucoma, meaning "green tumor," is one given when the nature of the disease was unknown. It has no significance now, but was suggested by the greenish appearance of the pupil, which is one of the advanced symptoms of the disease, and it usually appears when the affection has made so much progress in the interior of the eye that treatment is of little avail. Something was said of this when describing cataract. There is a form of glaucoma, called chronic, in which acute neuralgic pain is absent, but where the other symptoms, especially the hardness of the globe, are present to a greater or less extent. The ophthalmoscope enables the surgeon to see that in glaucoma the pressure in the interior of the eye is so great that the entrance of the optic nerve in the ball is actually a concave instead of being a plane surface.

Treatment.—The only effectual treatment for glaucoma is that discovered by Professor Von Graefe in 1856. After investigating and experimenting on the eyes of animals, Professor Von Graefe made an incision into the eyeball of a human subject having glaucoma, and removed a piece of the iris (*iridectomy*, cutting off the iris). This operation relieved the pressure within the eye, and cured the first patient operated upon. Since that time thousands have been operated upon with benefit, in all parts of the civilized world. Of course, however, there are patients having glaucoma, for whom the operation, no matter how skilfully performed, does no good.

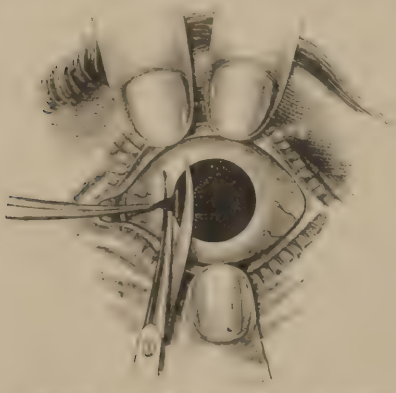


FIGURE 75.—The operation for iridectomy.

After all surgical operations, or even after every dose of medicine, the conscientious medical man may rightly say with the great Ambrose Paré, who, after treating soldiers on the field of battle, was wont to exclaim, "I have dressed you, may God cure you."

Injuries of the Eye—Foreign Bodies in the Eye.

The varying and innumerable occupations and sports of life render the eye of the human race, well as it is protected by lids and lashes, and by its position in a bony case, very much exposed to injury. From premature explosions, fragments of percussion-caps or grains of powder enter the eye. Machinists and all mechanics who work on iron, steel, or the other metals, are often struck upon the eye by bits of metal which sometimes lodge there. Even farmers at work in the harvest-field are not wholly exempt, for blades of grain may strike upon the cornea with such force as to lodge there. Children playing with a rose-bush may rub a thorn into the eye. Workmen mixing mortar, or carrying it, may splash some of the corrosive material so that it strikes the conjunctiva. Knife-makers may, by the breaking of a blade, be cut upon the eye. Children, with scissors and knives, may mutilate the organ of vision. Gunshot-wounds are received in the eye. A child, playing with its nurse or mother, may scratch the transparent front of the eye. This catalogue of injuries, which have occurred and do occur to eyes, might be almost indefinitely increased, so that we may almost assert that a large part of the

occupations of adult life, and the sports of childhood and youth expose the eyes to danger.

An injury of the eye is always a serious matter, but all injuries are not equally serious. A bit of steel in the front of the eye is often removed by a skilled fellow-workman, and a few hours' rest or protection of the eye causes the wound to heal, and the organ to be as useful as ever. Other particles, however skilfully removed, may leave a scar behind, although the patient experiences no other inconvenience. In other cases, however, the foreign body enters the cavity of the eye, whence it can only, in rare instances, be removed without injury to the globe and destruction of vision.

When the injury is a large wound, the eye is often irreparably damaged at the instant of the accident.

The most serious condition of all that have been enumerated, however, is when a foreign body left in an eye, or an injury to it, causes what is known as a sympathetic affection of the uninjured eye. There is always danger that a foreign body in the eye may cause this form of inflammation. It is, therefore, a safe rule to remove a foreign body from an eye at all hazards. Of course, the expert will find some exceptions to this rule, but the unprofessional person will not be justified in making any such.

An injury of the eyeball, especially of that region known to medical men as the ciliary region (see Anatomy of the Eye), is also, even when there is no foreign body in the eye, dangerous on account of its power of exciting sympathetic disease in the fellow eye.

Symptoms.—The prominent symptoms of sympathetic ophthalmia are:

1. Blurring of the vision, so that the subject cannot continue to read, or sew, or occupy the eyes at work on near objects, without a fatigue or watering of the eyes.

2. Inability to bear light.

When these symptoms occur in the same eye, a patient who has a foreign body in one, or who has at any period, however remote, severely injured the fellow eye, the case is most serious, and demands prompt consideration.

When it has once been decided that the injured eye is the cause of the trouble, if a foreign body remain in it, it must be at once removed, and if this do not at once arrest the trouble, the eyeball in which it was should be cut out.

In case the sympathetic trouble arise from the injury of the fellow eye, without the presence of a foreign body, the rule is also to remove the injured eyeball, in order to save its fellow. If these

early symptoms of sympathetic irritation be not carefully noted, and the affection pass on to be an inflammation of the iris and deeper parts of the eye, removal of the globe of the eye will not always, nor indeed often, arrest the disease, and the patient will become blind. Hence the necessity for the most careful attention to the early symptoms from injuries to the eye, as well as to those from foreign bodies that have entered it.

The subject of foreign bodies *upon* the eye has already been mentioned on a preceding page, and nothing more need be said as to the method of removing them. It is hardly necessary to say that none but a surgeon will endeavor, except in the direst necessity, to remove a foreign body that has fully entered the organ of vision.

Artificial Eyes.

After an eyeball has been removed by a proper surgical operation, the appearance of the patient may be much improved by the insertion of an artificial eye. These are made so beautifully of porcelain, that if inserted when the muscles that move the ball have been left, they will often almost entirely conceal the loss.

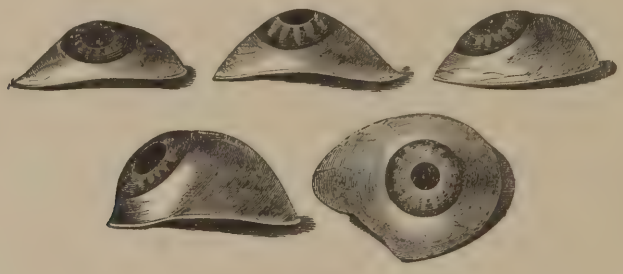


FIG. 76.—Artificial eyes.

They cannot always be worn, on account of the irritation they cause, but generally they can. These eyes cost from five to ten dollars each, and one will last with good usage from one to two years.

Cross Eyes—Squint—Strabismus.

When the muscles that cause the movements of the eyeball act together in proper accord, at every motion of the globes the lines of vision exactly agree, so that the image of the object looked upon is formed at exactly corresponding parts of the two eyes. When,

however, the muscles are unequally balanced, one eye will look in one direction, and the other in another, just as the head of a horse may be turned by his driver away from or toward his fellow, or held exactly parallel with it by the use of the guiding rein. This deviation of the eyes forms a conspicuous defect or deformity. It is chiefly seen in one of two forms : either an eye turns inward or outward. There are, however, cases where an eye turns upward or downward, although these are rare. The cause of these deviations is to be usually found in one of two influences :

1. Paralysis of the muscle of the outer side of the eye will, of course, cause it to be so overbalanced by its antagonist that the eye is turned inward. This paralysis—to go back to our illustration from the reins of a horse—is to be compared to the loss or severance of the rein on one side, while the other is still in the hands of the driver.

2. The most frequent cause of strabismus or squint, however, is not paralysis. By far the greater number of patients who turn their eyes inward or outward, use all the muscles of the eye very well, and turn the eye in any direction, but they are not able to cause the eye to be moved in such a way that they direct the line of vision to exactly the same point when the muscles are *all* in action. This may be easily tested in the following manner : Let the person to be examined close one eye, and cause him to follow the finger, a pencil, or some such object while it is moved about, above, below, to the other side. If there be no paralysis, the eye will follow all these movements without any movement of the head. If paralysis exists, however, the patient will move his head in order to get a view, and the eyeball will stop in its movement outward or inward, upward or downward, according to the muscles that are affected.

The most frequent cause of strabismus is a congenital want of development, or excess of development of the eyeball, so that one set of muscles acquires a greater power than the others. (See paragraphs on Eyes requiring Spectacles.) Thus, eyes that are too short most frequently have an inward squint, while an eye that is too long squints outward. Comparatively few, however, of the cases of insufficient, or too great focussing power of the eyes have strabismus as a result, so that we are led to conclude that other factors have much to do in causing the deformity. Eyes that are too short require convex glasses, but one eye may need a stronger one than the other. They are more apt to deviate than those that are of the same length, or, to state it more technically, that have the same refractive power. A disease such as cataract or opacity of the cornea, affecting one eye, and preventing the

use of the two eyes at the same time, assists in causing strabismus.

A deviation of the eye inward is usually associated with want of focussing power, or with an eye that is too short from before backward—the so-called hypermetropic eye. It is usually first seen in children when they have reached three years of age, or when they begin to fix their eyes upon comparatively small objects, such as their toys. Thus mothers constantly affirm that their children did not squint when they were born. They are correct, but most of these children who afterward squint, would have done so immediately after birth had they the power to look at objects fixedly or intently. Any one who has observed the habits of infants and young children will remember that fixing the gaze upon a near object requires considerable use of the muscles that pull the eyes inward, and that it is an acquirement just as much as learning to walk. It is when the eyes are continuously used in this manner that the squint is observed. Sometimes it is not constant at first, but periodic; it usually, however, soon becomes fixed.

Both eyes commonly squint in convergent strabismus, although one much more frequently does so. In other words, one eye squints by preference, while the other is used for seeing. For some unknown reason, the vision of the eye that generally squints becomes blunted. The use of tests, such as type, generally shows that the squinting eye does not have nearly as good visual power as the other. Thus, we often find that the patient is only able to see large objects with the eye that deviates. Yet the most exact observation of the optic nerve or retina does not always, or usually, find any reason for this loss of vision. It is a happy thing for the squinting patient that the vision does thus become blunted. Were it not so, he would see all objects doubled. Double vision is one of the most distressing of symptoms, and although usually observed in strabismus from paralysis of the muscles, is seldom found in the strabismus arising from an improper shape of the eyes.

Treatment.—The treatment of strabismus depending upon paralysis has already been dwelt upon in speaking of that subject. It will be sufficient to say here, that the cause must be sought out, and if the affection be not of too old a date, it may often be relieved by appropriate internal treatment. Strabismus depending upon a faulty shape of the eyeball—which is, so to speak, a local disease—can only be remedied by an operation. Some writers contend that the continued use of sulphate of atropia, which suspends the power of accommodating the eye to different distances, may in time, with the use of the appropriate glasses,

cure the deviation, but the present writer has not been convinced by the reports as yet made of the success of this treatment.

The operation for the relief of strabismus consists in separating the squinting muscle from the attachment to the globe of the eye. It then grows again to the eye, but at a point farther back, so that its power over the eyeball is reduced. It is usually necessary to operate upon each eye, although not always, and sometimes more than once on the same eye. They are generally not operated upon at the same time, but the effect is carefully watched after the first operation. The operation for squint is quite painful, and is usually performed while the patient is under the influence of an anæsthetic. After the operation, the want of vision of the eye should sometimes be corrected by the use of the proper glasses.

Paralysis of the Muscles of the Eyeball.

This affection is not always so strongly marked as to cause any deformity. The eyes may, to all ordinary observation, seem to be perfect in their associated movements, and yet one or more of their muscles may be paralyzed. The patient, however, will most keenly feel even the slightest deviation. If the two eyes are not acting in exact harmony with each other, a most troublesome double vision will occur. The slighter the deviation, the greater will be the annoyance ; hence a paralysis that can only be detected by very fine tests will often cause a distressing double vision.

Any, or even all of the muscles of the eye may be paralyzed. The most frequent cases are those in which the eyelid droops, the pupil is dilated, and the eyeball turns outward. All these parts are apt to be paralyzed at the same time, because one nerve (the third of the nerves going out from the base of the brain) supplies these parts. The eye may turn in from paralysis of the nerve supplying the muscle that draws the eye outward, or the lid may refuse to shut from paralysis of the circular muscle, which closes the lids.

The Treatment of any of these, or other forms of paralysis, depends upon the cause. Among the prominent causes are syphilis, tumors of the brain, rheumatism, pressure upon the trunks of nerves from blood-clots, pieces of bone that have been broken, etc.

Constant Oscillatory Movement of the Eyes—Nystagmus.

This symptom is seen very frequently in Albinos. The eyeballs are never quiet, at least in working hours, but are constantly being moved about, as if in search of some object upon which to rest. The affection is caused by various diseases of the

eye, which prevent the formation of a sharp image upon the retina. The patient is not able to get a sharp, well-defined image at any point. He is like a person looking through an improperly focussed opera-glass, which he is not able to adjust. It is probable that the habit of moving the eyeball in all directions is induced by the attempt to gain clear vision. The affections causing nystagmus are usually incurable. Some of them are want of development and wasting of the retina, dense opacities of the cornea, congenital cataract, want of development of the whole eyeball, etc. Miners who spend much of their time entirely deprived of sunlight, sometimes become affected with nystagmus. This fact helps materially to explain its cause. It would seem to arise from the want of sufficient illumination to view any one object with distinctness. One author believes that nystagmus occurs in consequence of the prolonged looking upward required in mining. It is also said to be a symptom of some diseases of the spinal cord.

Inability to Use the Eyes Continuously when there is no Inflammation and no Lessening of the Sharpness of Sight.

There is a troublesome combination of symptoms, grouped by physicians under the general head of Asthenopia, or weak-sight, that usually depends upon the failure to wear glasses when they are required. It will be fully discussed under the head of Spectacles.

There are, however, some cases in which general muscular debility, diseases of the other parts of the body, notably of the womb, cause what is called a reflex disease, and prevent the patient from any prolonged use of the eyes. A careful examination of the eye as regards its need for glasses should always be had, however, before a case is declared to be one depending upon general debility or organic disease of another part of the body. The results of the scientific investigations of the past twenty years, by showing the true use of spectacles, have rescued thousands of condemned eyes from inactivity and uselessness. Asthenopia depending upon constitutional causes, chiefly requires of course constitutional treatment.

Conditions of the Eye requiring the Use of Spectacles.

The history of the invention of spectacles still remains in much obscurity. After the art of making glass was discovered, lenses were soon made, and were used as burning glasses. Aristophanes (B.C. 424) alludes to them in his comedy of the "Clouds." It is said

that the vestal virgins used convex lenses to kindle the sacred fire, and surgeons also employed them as actual cauterants. Seneca (A.D. 65) noticed the magnifying power of a bottle of glass in enlarging small letters. Roger Bacon, or Friar Bacon, born in 1214, certainly knew something of spectacles, if he has no claim to be their inventor, for a writer, in 1551, thus speaks of a "glasse" used by Friar Bacon: "Great talke there is of a glasse he made at Oxford, in which men might see things that weare don, and that were indulged to be don by power of Evile Spirites." And in his own writings Bacon says, "This instrument (a plano-convex glass, or large segment of a sphere) is useful to old men, and to those that have weak eyes, for they may see the smallest letters sufficiently magnified." It is probable that they were in use at the time of his death in 1292, whether Bacon knew about spectacles himself or not.

Alexander de Spina, a native of Pisa, who died in that city in 1313, having seen a pair of spectacles that were made by another person, who was unwilling to make his method known, caused a pair to be made for himself, and then, in a liberal spirit, made his invention public. On the tomb of a Florentine nobleman, who died in 1317, it is said that he whom the stone commemorates was the inventor of spectacles. The spectacles thus invented, however, were those to be used by old persons. Thus their value was limited to a relatively small class. Our time has largely amplified the variety of assistances to read, so that young and old now derive advantage from the great discovery of the uses of glass as means of assisting the sight.

The eyes that require and are benefited by spectacles, may be divided into three great classes. There are subdivisions of these classes, but in order to simplify discussion I will first speak only of these chief varieties of eyes:

1. *The Far-sighted Eye of Old Age.*

This is an eye that has become practically too short—an eye with an insufficient focussing power (*presbyopia*).

2. *The Far-sighted Eye of Youth.*

The eye that is actually and congenitally too short from before backward (*Hypermetropia* or *Hyperopia*).

3. *The Near-sighted Eye.*

Or the eye that is too long from before backward (*Myopia*).

This classification is no artificial one. It does not depend upon the dogmatic assertion of medical theorists, but upon the anatom-

ical structure of the eye, and the inevitable processes of decay in human strength, and has been determined by accurate investigation and experience.

While we are indebted to a long line of scientific worthies for the gradual progress which has finally enabled us to discriminate as to the kind of spectacles which should be worn in different cases, to Dr. F. C. Donders, Professor of Physiology in the University of Utrecht, belongs the honor of having arranged the whole subject, enriched by very many of his own investigations, in an harmonious whole. His great work on the Refraction and Accommodation of the Eye, was first written in the Dutch language, but it has been translated into the English and German, and is everywhere recognized as the highest authority on the subject of which it treats. The views that are here presented are mainly derived from this work.

Presbyobia.

The eye of old age requires spectacles ; not because the cornea —the anterior transparent coat of the eye—becomes flattened in advanced life as is often said, but because a little muscle within the eyeball, called by anatomists the ciliary muscle (see Anatomy of the Eye) loses some of its power as old age comes on. This little muscle

FIGURE 77.—Sections showing : I. the normal eye ; II. the myopic one ; III. the hyperopic.

passes around the eyeball and connects the cornea and iris to the choroid coat and to the ligament which holds the lens in position. The vigor or tone of this muscle becomes impaired with advancing years. Its ordinary work is that of making the lens of the eye thicker than it is when the eye is in a state of rest. The rays of light coming from a near object—from the page we are now reading, for instance—have a divergent course ; they are continually going away from each other ; when they come from an object much further off they are parallel or nearly so. Thus the rays from the music on a piano do not come to the eye of the player

as divergently as those from her sewing, which is held nearer than the music, and the further the illuminated object is removed the less divergent, the nearer parallel the rays become. In every act of changing our gaze from a remote object to a near one, the lens of the eye becomes thicker ; in other words, during the act of accommodating the vision for a near object. It must then be relaxed, become thinner, in turning one's eyes from an object near at hand to one that is far removed. The lens also loses some of its natural elasticity with advancing age. It can no longer undergo this alternate change with the same readiness as in youth. Thus we have two factors, both acting *within* and *not without* the eyeball, that impair the adjusting power of the eye. No eye-cups to lengthen the ball, no process of straining upon the eye, will ever be of any but the most harmful assistance in attempting to overcome these natural and senile changes.

The small object which the man of fifty desires to see, is held further off than when he was thirty, because he can then have the benefit of rays of light that are less divergent than those coming from it when it is very near him. They will then, of course, not require so thick a lens to unite them to a distinct image upon the retina. The little, enfeebled ciliary muscle will not be required to do as much work. That work has been constantly done, except during sleep, ever since our baby-eyes began to look wonderingly from the rattle to mamma's face. As we turned from the book we were reading to the landscape before us, in all the multifarious employments of life which require a different adjustment of vision, the ciliary muscle has become alternately tense and relaxed, the lens increased and lessened in size. The vigor of the muscle is at last impaired, the faithful servant has become feeble with age.

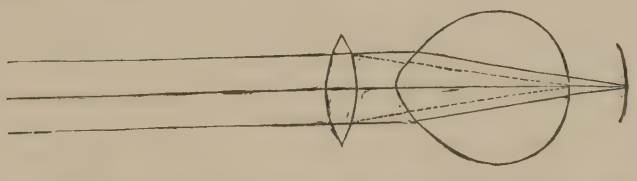


FIGURE 78.—Showing the action of a convex lens placed in front of an eye that is too short. The dotted lines show the increased convergence caused by the lens.

The great invention of spectacles is now made available to restore the lost equilibrium. There is not enough power for the work demanded. A double convex lens, just such an one in shape as the one inside the eye, is placed outside of it, in front of it, in a spectacle frame. The lens within the eye is thus practically made thicker, and the book may be held at the old and proper distance. Perhaps

the reader has sometimes wondered why old persons lift up their spectacles or remove them when they turn from a book or newspaper to the face of some one with whom they wish to converse. By remembering what has above been said about the rays of light being the less divergent the farther off the object from which they come, and that the lens requires to be made thicker in proportion to the nearness of the object, this will be easily understood. The old people who are to be seen working without glasses, were born with an eyeball which is too long. The senile changes which tend to shorten the eye are then counterbalanced or neutralized by the congenital malformation. This is probably the explanation of such cases as those of Cicero, Humboldt, and John Quincy Adams, which are sometimes adduced as evidences that old eyes may not need glasses. Professor Donders thinks that the most useful eye is one that is somewhat short-sighted, for the reason that in advanced life glasses need not be used for reading and writing by such persons. These subjects are apt to boast of the superiority of their eyesight over that of their neighbors. If we place a weak concave lens before their eye, we can soon convince them that they can see objects at a distance better with than without its aid. The superiority of their vision, then, is limited to near objects. As a general rule, glasses are required for reading, writing, or the like, by all people who are not near-sighted, after the age of forty-five. Those who are born with eyeballs that are too short (hyperopes), will often require them at a much earlier period. Short-sighted people go on until fifty or sixty years of age, or even entirely through the three score years and ten, without needing glasses to read with. But it is an error to suppose that the vision of near-sighted people improves for distant objects as life advances.

Hyperopia.

Eyes that are congenitally too short require glasses. This state of arrested development includes quite a large proportion of human eyes. Many eyes never suffer inconvenience from the defect, and are able to do their work, until the far-sightedness of age occurs, without glasses. To very many, however, in whom the defect occurs, the inconvenience is so great that no continuous work with the eyes is possible, unless provided with spectacles. The researches of Donders were a great boon, for, supported by his investigations, physicians began to prescribe their use to thousands who had been before denied them. Until Donders clearly demonstrated the anatomical condition at the base of the want of vision of this class, their fate was sad indeed. They were deemed un-

fortunates who had the eyes of old people, but to whom it was dangerous to give glasses, or, still worse, they were considered as victims of incipient blindness, which could only be warded off by the most vigorous anti-inflammatory regimen. Such patients were often confined to darkened rooms, cupped, blistered, and salivated; in short, they were in many instances the victims of actual martyrdom. The only source of relief — that is, the use of convex glasses—was absolutely prohibited, lest the weakness of sight should end in complete blindness.

Those who did not suffer from actual treatment for the unknown, anatomical condition, were often denied the privilege of using their eyes, and in England were advised to enter upon such employments as sheep-farming in Australia, while in other countries similar uncongenial occupations were often urged upon those who, with the aid of glasses, could have been successful in chosen occupations.

The discovery that hyperopic patients, even when young, should wear glasses, and that many did actually put them on, without medical advice, much to their benefit, was made in 1848 or 1849, by Professor Chester Dewey, then in Union College. He published his observations in Silliman's Journal, Vol. VIII., p. 443, but they escaped the notice of physicians. Hence the United States lost the priority in proclaiming relief to a large class of sufferers.

It was found by the ophthalmoscope that this class of eyes, now under consideration, were too short. Hence, both divergent and parallel rays would only come to a focus or unite behind the retina. The loss or indistinctness of sight was explained. In convex glasses, which would make this eyeball, which was too short, of the proper length, a remedy was found. There were no evil consequences to be feared from their use, since their effect was purely mechanical, just as we have seen is the case in the use of glasses for presbyopia. There are several grades of this congenital shortness of the eyeball. In a large proportion of cases, as has been said, no glasses are required, because the patient can overcome the defect by a very slight extra and unconscious muscular effort. There are some cases, however, where the patient cannot see any small type without glasses, nor can he see objects at a distance. These cases should have glasses as soon as the defect is discovered.

There is a larger class who can see for a very short time while looking at near objects, but whose eyes are soon tired, and incapable of an ordinary amount of work. This class also should wear glasses. There are other subdivisions of this defect. It is only

necessary to repeat what was said when treating of asthenopia or weak sight: that all cases of inability to continue to use the eyes for a reasonable time, should be carefully examined as to whether or not they require glasses. Much of the development of a child's character may depend upon its ability to use its eyes in a proper way and for the proper length of time. Far- and short-sightedness, uncorrected, may cause many defects more serious than the mere inability to see.

Myopia.

Short-sighted eyes, or those which are too long from before backward, require spectacles. This condition is one in which some patients are born. More, however, induce it by improper habits, which interfere with correct vision. It is a defect more common in Germany, probably, than in any country. If generation after generation overwork their eyes under improper conditions of diet, illumination, character of type, and so forth, a race of near-sighted people, or people who very easily become near-sighted, will be at last produced. This has occurred in the cultivated classes in Germany, and is occurring in the United States to an increasing extent.

Short-sighted persons do not usually need glasses for reading or writing, for the very simple reason that divergent rays of light are easily brought to a focus on a retina which is situated further back than it should be. Very little tension is required of their muscle of accommodation in uniting those rays. But in looking at a distance, when the rays of light which strike the eye are parallel, they have trouble. Do what they will, they cannot unite such rays to a distinct image on the retina. They unite in front of it.

The reader will remember that his short-sighted acquaintances cannot read signs; that they do not know their friends on the other side of the street; in short, they do not see things that are somewhat removed, unless they have their glasses on.

A concave lens, as we all know, disperses rays of light, producing just the opposite effect of a convex one, which collects them. Parallel rays are thus changed into those that are divergent. When a concave lens is placed before the eye, the eyeball is, in effect, shortened,—made to approximate one of the proper length.

Any one who has normal eyes, who would like to know how indistinctly short-sighted persons see objects at a distance without concave glasses, should step into an optician's, and put himself in their position, by putting on convex glasses, which will make his

eye too long. He may, after doing this, also experience the gratification of a short-sighted person, when he puts on correcting spectacles, and looks out on a world of beauty, which he sees distinctly for the first time. This latter will be done by neutralizing

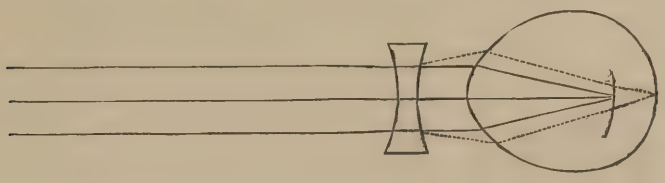


FIGURE 79.—Showing the effect of a double concave lens in dispersing the rays of light so as to focus them on the retina of an eye, the axis of which is too long.

the concave glasses by convex ones of the same focal distance. The experimenter has thus done what the oculist does for a short-sighted patient. The effect that is produced is purely mechanical, both in the eye naturally short-sighted, and the one artificially made so.

So far from the use of proper glasses being an injury to such patients, they are a positive benefit. A neglect to wear spectacles when the circumstances require them, will sometimes cause one eye to turn outward, and thus cause deformity. The short-sighted eye is essentially a diseased eye, and great care is required in its management; but spectacles rightly used assist in preserving its functions.

In the introductory part of this section, great stress was laid upon the necessity of a proper arrangement of the school desks of children, the illumination of objects, the clearness of the type, and so forth. It is a neglect of these precautions, as well as a failure to secure a proper amount of out-of-door life, good food, and all the other influences necessary to maintain a sound body and a vigorous muscular system, which lead, among other defects, to a softened and elongated eyeball—in other words, to short-sightedness.

It must be constantly remembered, that while far-sightedness from age is inevitable, and while the short eyeball of youth is a condition with which many are born, short-sightedness is not only often entirely acquired, but is also alarmingly increased by improper habits. Hence, many of the warnings as to the misuse of eyes.

Astigmatism.

As was said, there are defects requiring the use of spectacles other than those described under the three heads that have been discussed. The chief of these is *astigmatism*, from two words meaning not coming to a focus. Astigmatism may always be resolved into hyperopia or myopia, or into both. There is hyperopic astigmatism, myopic astigmatism, as well as a mixed form, in which the two forms of the defect are combined in one eye. This condition depends upon a defect in the shape of the eyes, just as do hypermetropia (the far-sightedness of youth) and short-sightedness. There is a want of symmetry in the refracting parts of the eye. Besides being a congenital condition, it is sometimes acquired from inflammation of the cornea. When astigmatism exists, one part of the eye may be of the normal shape, while another is far- or short-sighted; or the whole eye may be of improper length, although one part is more defective than the other.

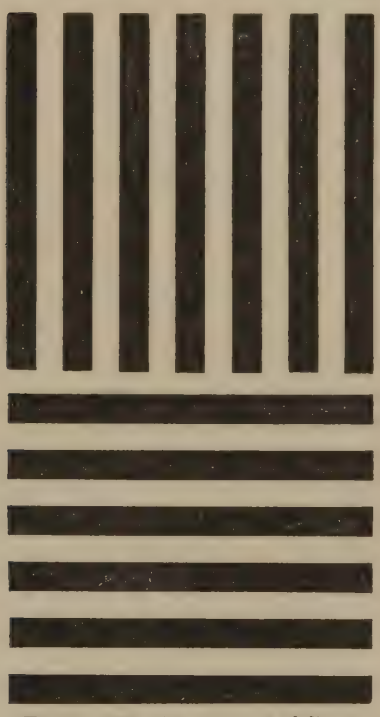


FIGURE 80.—Arrangement of lines to test the existence of astigmatism.

The troubles caused by this defect are more considerable than those caused by far- or short-sightedness. Patients see all objects distorted, and none of them clearly or for any length of time without fatigue. Yet persons suffering from these inconveniences often go on to adult life without knowing that their vision is remarkably defective, and sometimes they recognize that it is without being aware that there is a remedy.

Exact examinations generally show that astigmatic persons see horizontal lines much better than those that are vertical or the reverse. A test made with such lines as are represented in the accompanying woodcut will often detect astigmatism. Astigmatic patients, if ladies, are apt to indicate it by their inability to put on their neckties, and so forth, correctly, and such persons have been known to go about straightening pictures that were already properly hung.

Although there were isolated cases of correction of this defect by the use of glasses, notably the case of Airy, the celebrated astronomer, it was not until the time of Donders that physicians were enabled everywhere to correct it by glasses ground from a cylinder. The ordinary convex and concave glasses are ground from a sphere. It is probable that this defect, if uncorrected, has more effect upon the development of character, than either of the simpler forms of improperly-shaped eyes.

Color Blindness.

In this affection the patient is not able to properly distinguish all the colors of the spectrum. It is sometimes called Daltonism, from John Dalton, who first described it in 1794. Persons having this defect are usually born with it, although it is sometimes the result of disease of the optic nerve. Color-blind persons may not be able to distinguish red, or green, or violet, or they may be totally color blind, and may only perceive the form of objects.

Color blindness is more common in males than in females. One in twenty-five of males are said to suffer in some degree from this defect, while not quite one in a hundred of females are color blind. There is no remedy for this trouble. It is a very dangerous one when it occurs in men employed in running railway trains or ships, for they are not able to positively distinguish the color of the signals. In many countries and in some parts of our own, measures are being taken to secure an examination of all the railway engineers and switchmen. The best test for the detection of color blindness is that by means of colored worsteds. Those to be tested are caused to match the red, green, or violet, by means of the hundreds of various tints that are given them to select from. If color blindness exists, his inability to match one or more of the three colors will soon be shown. The color in which a person is blind seems to be gray to him.

Simulated Blindness.

For various reasons young persons and even adults sometimes falsely assert that they cannot see with one or both eyes. An inexperienced person will have difficulty in detecting this deception. The physician, however, by means of the ophthalmoscope and certain ingenious tests, is generally able to do so.

Hysterical Blindness.

There is a form of hysteria in which blindness is one of the symptoms. There is usually a basis for this simulation in a moderate defect in vision which the disease of the nervous system causes the patient to exaggerate. The treatment of hysteria will, of course, serve also to remove the trouble. It is very important, however, to act upon the mind of the patient by correcting, as far as possible, any real defect in sight that may exist.

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